GENERATION, TRANSMISSION AND APPLICATION OF THE POWER SERVICES

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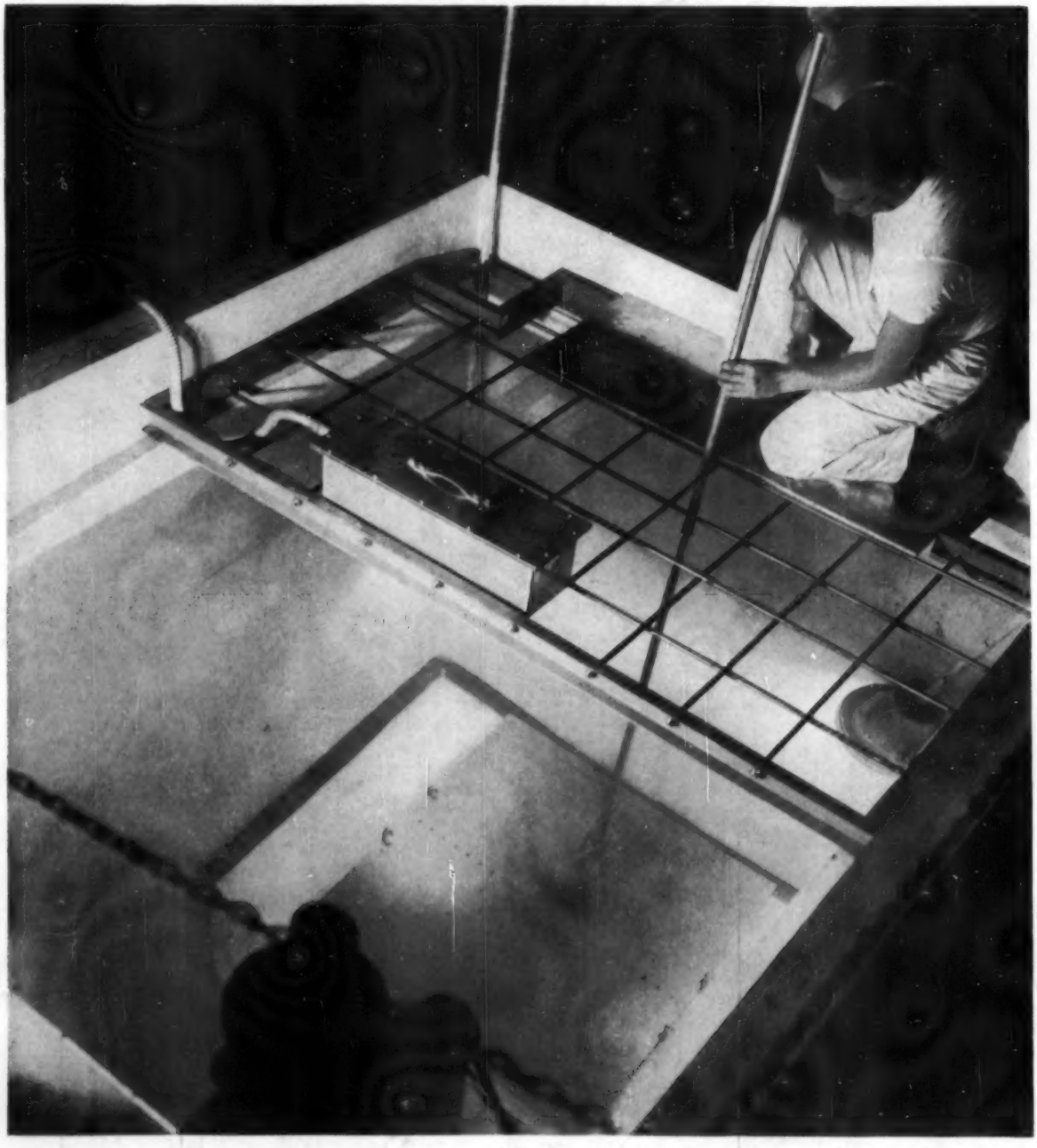
Power

JULY
1955·50¢

A McGRAW-HILL PUBLICATION



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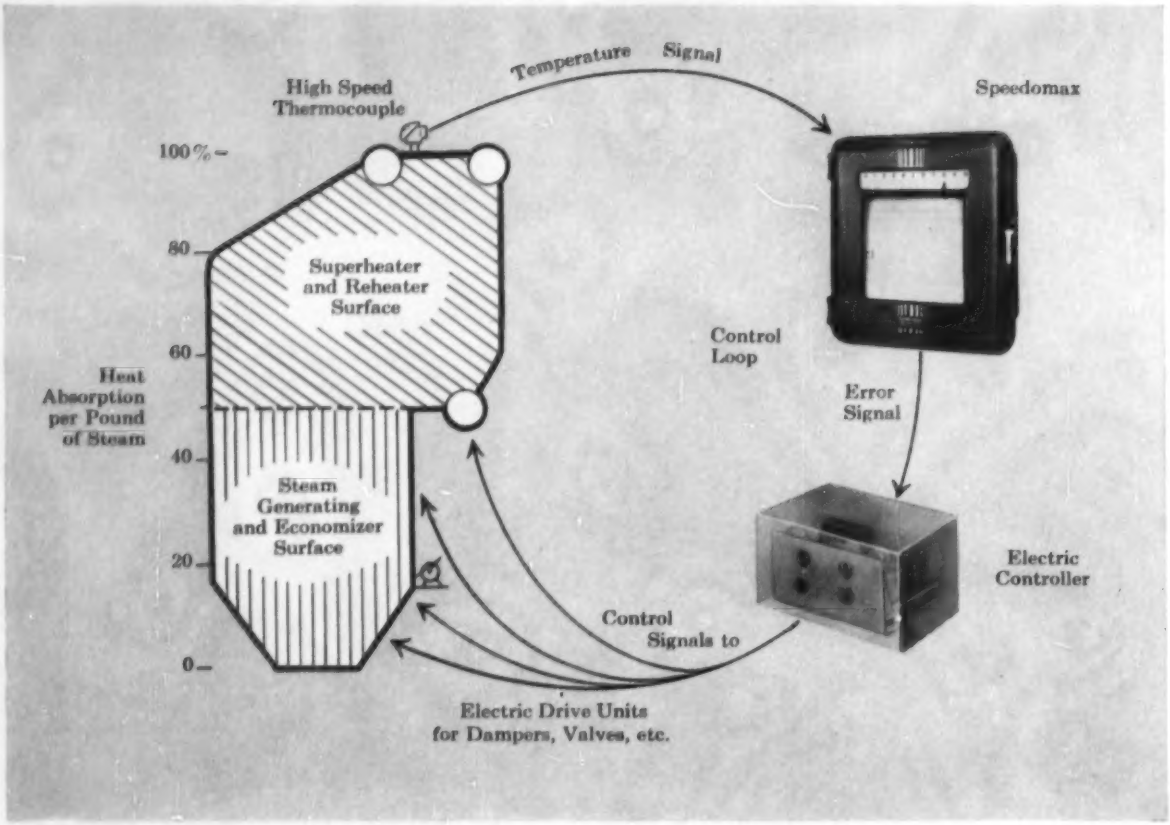


THIS STEAM TEMPERATURE CONTROL

puts heat where you want it!

● Because superheater and reheater surfaces of many modern boilers receive 50 per cent—or more—of the heat liberated, the proper control of heat distribution is a governing factor in attaining efficiency. Steam temperature control, by regulating this distribution, maintains optimum Btu /lb of steam, and helps prevent overheating of the metal surfaces.

L&N's *all-electric* steam temperature control solves this critical problem effectively over a wide range of load and furnace conditions. The basic components of the control are as follows:

High Speed Thermocouples—Especially designed to provide accurate sensing of temperature, with a response several times as fast as non-specialized thermocouples.

Speedomax Recorders—Provide sensitivity, accuracy and proved reliability of measurement; with auxiliary alarms and control safeguards specified for this very exacting service.

Versatile Electric Controller—With control actions—proportional, reset and rate—tailored to meet not only the requirements of a sing'e operating condition (such as control of a valve), but also of *added* operating conditions (as when control must be transferred to dampers or other devices). Preliminary control action, initiated from changes in boiler air flow, is similarly tailored for each operating condition. Reheat unit control systems are coordinated to prevent one temperature control from interacting with or upsetting the other.

Electric Drive Units—Provide dependable, positive positioning of dampers, valves, burners, etc. under conditions both normal and adverse.

Let our engineers work with you to arrive at an effective solution of your superheat—reheat control problems. Please address us at 4910 Stenton Ave., Philadelphia 44, Pa.

LEEDS NORTHRUP

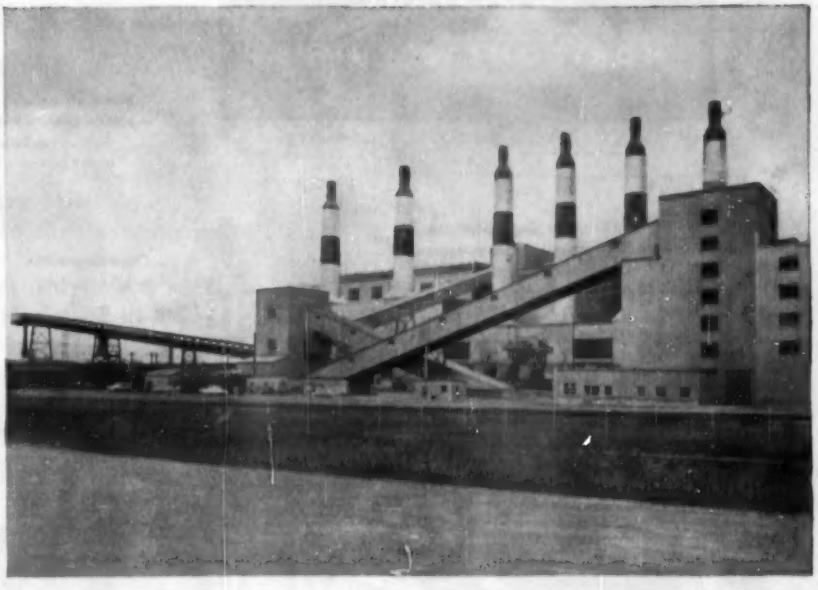
instruments automatic controls • furnaces

Coordinates coal handling for
3 stockpiles at Ridgeland Station

LINK-BELT builds and installs system for 1.3 million tons

RIDGELAND Station is an outstanding example of coal handling flexibility. By arrangement of parallel conveyors with chutes and motor-operated gates, the system can handle up to 1,600 tons of coal per hr. And should a fuel emergency arise, coal can be reloaded from storage to barges and transferred to other stations in the Commonwealth Edison system.

Whether your plant is large or small . . . your problems simple or complex—it's Link-Belt for top coal handling efficiency. Our engineers will gladly work with your own engineers and consultants to provide the lowest cost per ton handled.



Ridgeland Station of the Commonwealth Edison Company has one of the largest single station coal storage capacities in the Midwest. Handling provisions include receiving by barge or rail, conveying to and from storage, breaking and crushing for cyclone firing, and delivery to bunkers. Sargent & Lundy were consulting engineers.

LINK-BELT

COAL HANDLING EQUIPMENT

3. Coal loaded onto dock belts by crane or tower moves to junction house, then to station or on this inclined conveyor to 800,000-ton storage area.

1. Traveling bridge crane unloads coal from barges to 350,000-ton reserve or to belt conveyor leading to station.

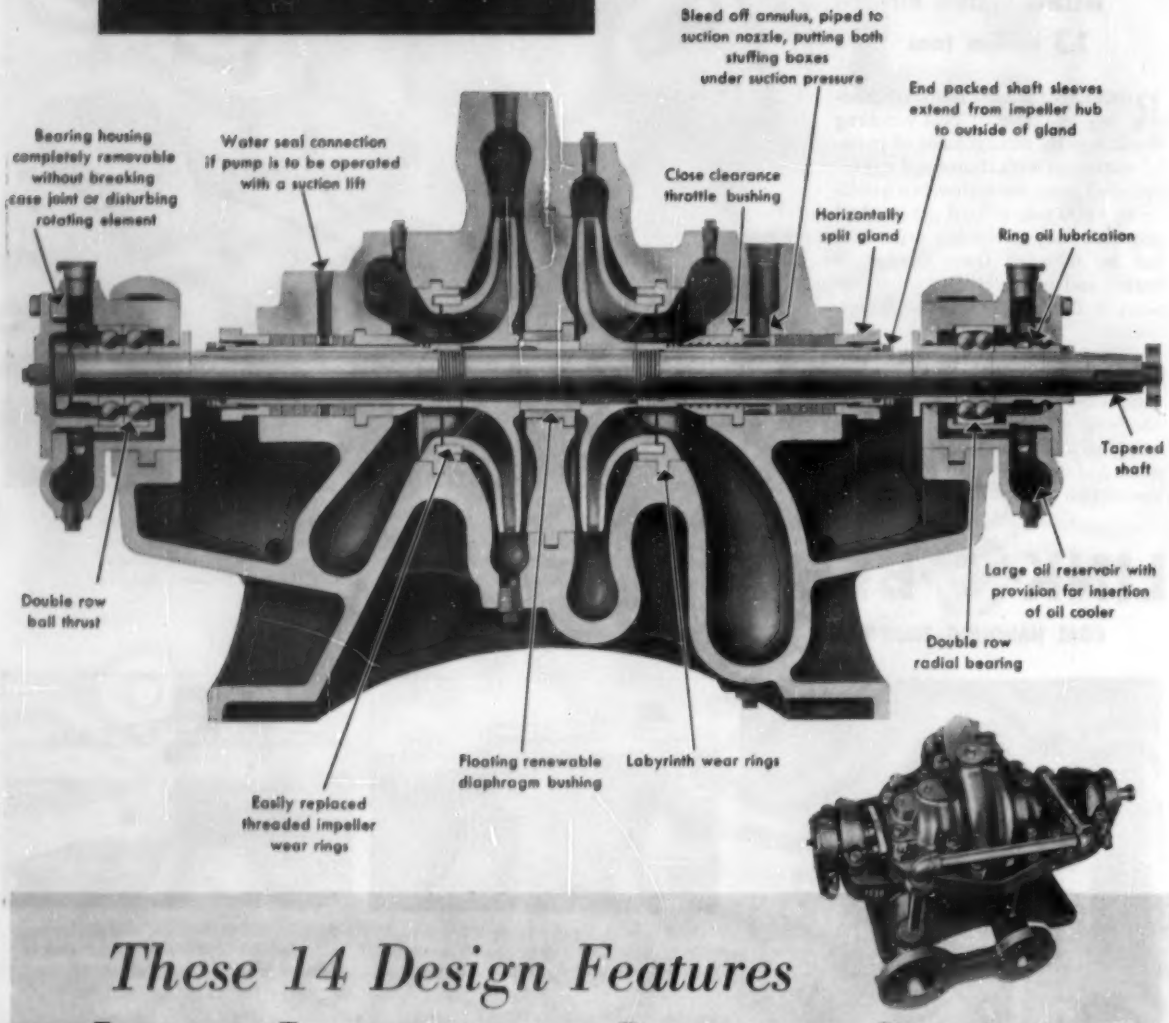
2. Stationary tower also unloads barges, empties to 170,000-ton storage area or hopper feeding 42-in. belt conveyor.

4. Parallel belt conveyors and flexible chute arrangements like this over bunkers assure steady feed of coal.

5. Discharging coal through dust seals, trippers are propelled along distributing conveyor by Link-Belt drive.

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World. 10,814

DE LAVAL
TWO-STAGE
HORIZONTAL PUMPS


Bleed off annulus, piped to suction nozzle, putting both stuffing boxes under suction pressure
End packed shaft sleeves extend from impeller hub to outside of gland
Bearing housing completely removable without breaking case joint or disturbing rotating element
Water seal connection if pump is to be operated with a suction lift
Close clearance throttle bushing
Horizontally split gland
Ring oil lubrication
Tapered shaft
Large oil reservoir with provision for insertion of oil cooler
Double row ball thrust
Double row radial bearing
Floating renewable diaphragm bushing
Labyrinth wear rings
Easily replaced threaded impeller wear rings

These 14 Design Features Insure Long-range, Low-cost Service

Look at the important design features highlighted in this cross-section. You will clearly see why De Laval 2IS-2KS Two-Stage Horizontal Pumps are designed to give you long, dependable, highly efficient service. ● These pumps are precision-made to quality manufacturing standards. They are available in capacities from 75 to 3,000 gpm, sizes from 2″ to 8″ discharge and heads to 750 feet. Write for Bulletin 1501 giving complete data.

DE LAVAL *Centrifugal Pumps*

DE LAVAL STEAM TURBINE COMPANY

815 Nottingham Way, Trenton 2, New Jersey

DL-559

Power

JULY 1955 • VOLUME 99 NUMBER 7

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POWER articles are indexed in both the *Industrial Arts Index* and the *Engineering Index*. POWER publishes its own annual index.

WATER-FILLED TEST PIT in the Knolls Atomic Power Lab, *cover*, is typical of equipment being used today to pin down quantitatively the effect of radiation on materials. As pointed out, *p 94*, radiation deteriorates a material's properties, with but few exceptions. You might compare the end result to effects produced by intense local heating of a material.

How much radiation can be withstood? Most of the common organic materials withstand about 10^8 thermal neutrons per sq cm without drastic change in properties. Organic liquids usually thicken, so possible solidification of liquid lubricants may pose a serious disassembly problem. This fact at once suggests using synthetics in place of hydrocarbon lubricants where exposure is large enough to warrant added cost.

Next month . . .

Boiler blowdown technique has been argued for years. In the upcoming issue, a well-qualified boiler man settles the matter (we hope!) with some considered answers to pertinent queries plus a string of top-quality photos showing proper sequence for opening and closing control valves.

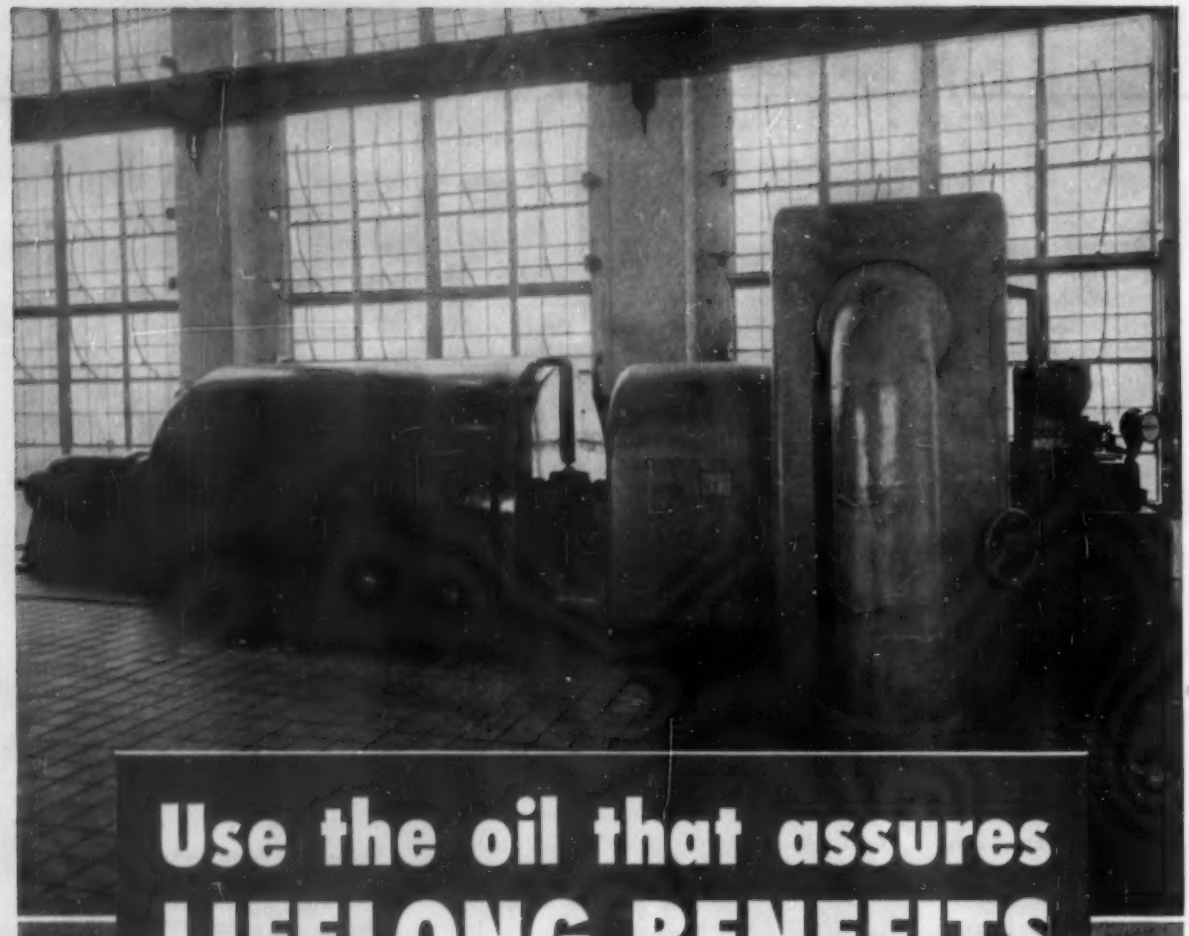
Consulting engineers for plant operating problems? This August article outlines some of the ways a consultant can save operating dollars: look for tips on "getting along" with consultants.

Draft-fan selection boils down to applying principles to practical design problems. That's precisely the tack followed in this upcoming article: a follow-up on the May story outlining fundamentals.

Outdoor power plant 20 miles from the sea and boasting of 512,000-kw ultimate capacity: that's the Valley Steam plant just north of Los Angeles. This completely outdoor station, one of the largest using cooling towers for circulating water, will be described in the lead article next month.

. . . and future months

Modern Plant Yearbook Issue in Mid-September promises to be a honey. Watch for Modernization citations!



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Power

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Our need for an Assistant Editor may be your big opportunity

► A YOUNG ENGINEER, with creative as well as practical ability and a bent toward technical journalism, will shortly join POWER's editorial staff. The spot is still open so you may be just the man we are looking for. This new Assistant Editor may be schooled in electrical or mechanical engineering. He has spent several years in the design, operation or maintenance of the power services, preferably in manufacturing or process industries. Here are some of the things he will be doing as part of POWER's editorial team:

DEVELOPING IDEAS, for articles, special reports, is basic to an editor's job. He doesn't sit back with a blue pencil waiting for articles to drop over the transom. More often he is first to break technical ground by spotting new and better methods, reporting them directly or locating the best-qualified engineer-author to tell the story.

TRAVEL plays a significant part in an editor's operations. A POWER editor spends 10 to 20% of his time tracking down article leads, attending engineering society meetings, visiting readers in their plants. This is the only way to keep abreast of current technical problems, to learn who is solving them and the best methods being used.

MEETING PEOPLE to gather facts and exchange ideas is another stimulating portion of the over-all editorial job. Editors are active in engineering societies—make occasional talks before both technical and lay groups. Wherever engineers meet in plants, shops or technical committees to swap notes, you'll find a POWER editor.

OUR WRITING is based on facts, straight from the field, put across to the reader fast and clear. Such good writing can be taught. Although most POWER editors acquired their writing skill on the job, many displayed an interest in writing earlier in life: as staffers on their school papers or later in professional life as engineer-authors.

Working closely with POWER's seasoned editors, this new man will have ample opportunity to learn how a top editorial staff gathers engineering information, organizes it for maximum usefulness, then presents it in clear, easy-to-grasp style. If the above summary appeals to you, not merely as a job but as a way of life, if you have the necessary engineering savvy plus journalistic leanings, write now, including all pertinent facts, to L N Rowley, Editor.

with Power readers...

THEY LIKED 'TODAY'S MOTORS'

We have carefully reviewed the 32-page special report "Today's Electric Motors" that appeared in your June issue and certainly wish to compliment you on its contents. The coverage of motor selection, motor characteristics and buying tips is well done.

However, we note the term *journal* rather than *sleeve* bearing is used in Table 2 on p 74. We find the sleeve-bearing connotation is more widely used in the small integral and fractional-hp business, which is the segment of the market we serve.

Will reprints be available?

M J CONNOLLY Jr
Manager, Headquarters Sales
The Hoover Company
North Plainfield, N. J.

Reprints are available. The charge is 60c each in quantities less than 100, 50c each for orders beyond 100. Address request to Reader Service Dept, POWER, *330 W 42 St, New York 36, N. Y.*

(*Continued on page* 178)

B&W NUCLEAR STEAM

Selected for

CON EDISON'S ATOMIC POWER STATION

Progress toward large-scale use of atomic energy took a giant forward step with Consolidated Edison Company's decision to build a nuclear steam-electric generating plant at Indian Point, N.Y. The first privately financed atomic plant in history, Con Edison's 250,000 kw station will rank with the largest conventional fuel plants now being built.

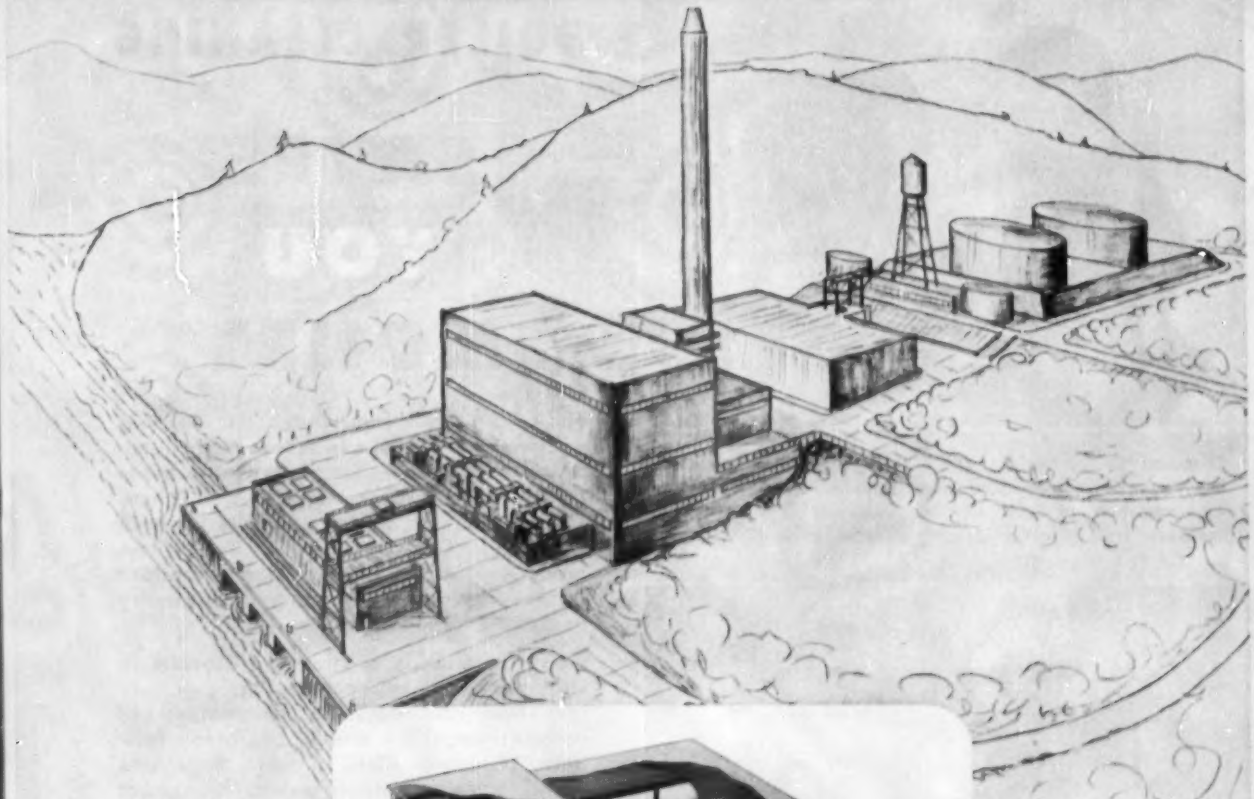
Con Edison's farsightedness in going ahead with private development of atomic energy is in the tradition established by its founders when electricity was first brought to New York City by Thomas A. Edison 73 years ago. To Con Edison, as to B&W, atomic fission represents a new and valuable source of heat — to be harnessed to develop electricity in a safe, efficient manner for the benefit of its customers.

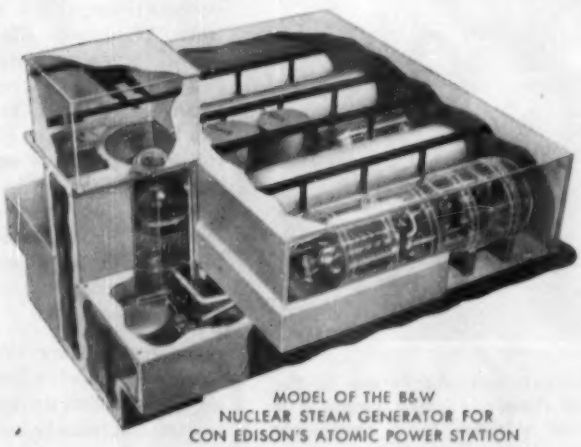
In selecting Babcock & Wilcox — an experienced supplier of steam generating equipment — to design, fabricate and erect the nuclear steam generator for the Indian Point plant, Con Edison recognized that a large share of the skills involved in nuclear power concern heat transfer, steam generation, fluid flow, high pressure piping, metallurgy, welding, and similar fields — in all of which B&W is a recognized leader.

Another basic consideration in this decision was that B&W, with its thousands of man-months of experience in nuclear power, is in a position to negotiate a fixed price contract for the required equipment, in the same manner as for a steam generator using conventional fuel. When its new fuel element fabrication plant now under construction near Lynchburg, Va., goes into operation, B&W will be capable of fabricating almost 90% of this equipment in its own shops.

Since the first days of the Manhattan Project B&W's experts have been called on for solutions to many of the special problems which arise in atomic energy. Today, more than 100 experienced B&W nuclear physicists and engineers, working in concert with B&W's large staff in conventional steam generation and its allied arts, are directing the wide range of atomic energy projects which B&W has been awarded. The best guarantee of realizing the full potentials of nuclear power at the earliest possible date is this combination of an intimate knowledge of atomic energy with nearly a century of steam generating experience. The Babcock & Wilcox Company, Atomic Energy Division, 161 East 42nd Street, New York 17, N. Y.

GENERATOR





MODEL OF THE B&W
NUCLEAR STEAM GENERATOR FOR
CON EDISON'S ATOMIC POWER STATION

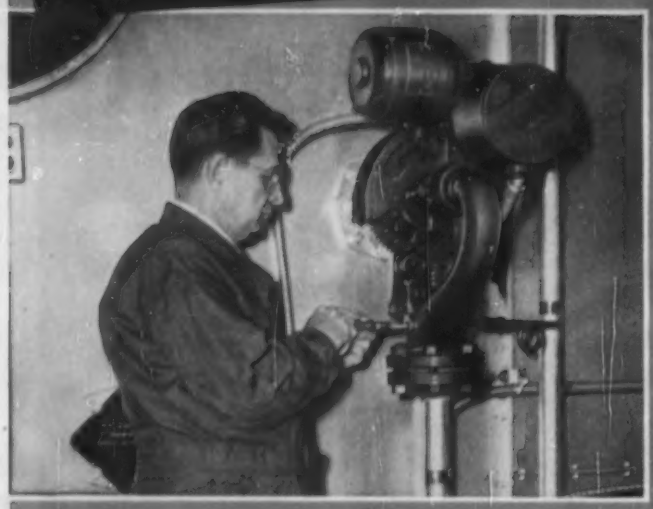
BABCOCK & WILCOX

ATOMIC
ENERGY
DIVISION

DIAMOND SERVICE POLICY

Improves

BOILER CLEANING AND SAVES YOU MONEY



Diamond Service Engineer needs only a screwdriver to change the steam blowing pressure of an individual G98 Blower after his inspection of tube surfaces indicated that a pressure increase will improve cleaning in that particular location.

Diamond Service Engineer instructs operator in use of the Diamond Selectromatic Control Panel . . . how simple it is to change from single blower selection to a completely automatic sequential program.

The severe punishment that boiler cleaning equipment must take in the normal course of its operation emphasizes the importance of the unique Diamond Service Policy. Throughout the 36 years it has been in force, this Diamond Service Policy has made significant savings and important improvements in boiler cleaning for many users of Diamond Blowers.

Every installation of Diamond Blowers in stationary water tube boilers is regularly inspected and adjusted *(unsolicited and without charge)* by one of the many full-time Diamond Field Service Engineers working from strategic points throughout the country. On an inspection call, the Diamond Service Engineer sees to it that the blowers are in good repair and adjustment . . . instructs operators in their correct use and care . . . recommends blowing schedules for maximum economy. Often he will detect potential trouble before it becomes serious or costly. This preventive maintenance has been of great value to many operators.

Numerous users tell us that this unique Diamond Service Policy was as important as the superior design of Diamond Blowers in their decision to buy Diamond equipment.

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Make Sure Your Boilers Are Correctly Cleaned...and AT LEAST COST

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DIAMOND SERVICE IS EFFECTIVE PREVENTIVE MAINTENANCE

Gadsby Plant, located on the outskirts of Salt Lake City, is the largest steam-electric generating station in UP & L's system.

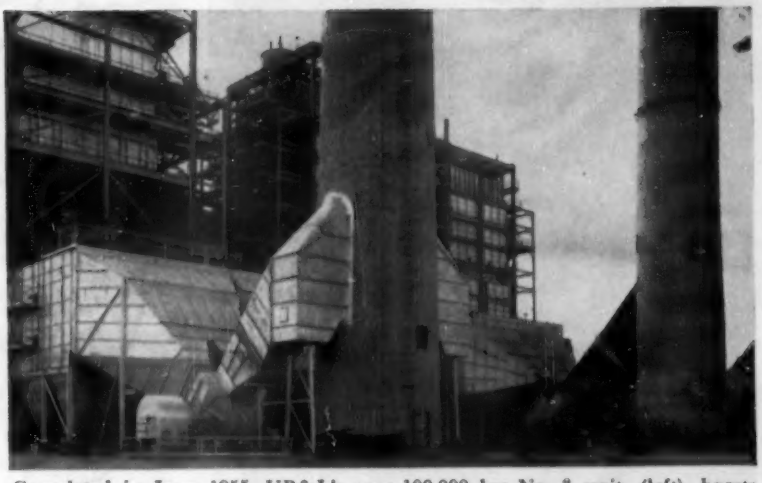
Utah Power & Light doubles capability

IN THE VAST Utah-Idaho-Wyoming-Colorado area where the Utah Power and Light Company serves some 700,000 people, raw minerals and chemicals are in abundance. Industries' influx to develop these natural resources is increasing at a rapid rate. So much so, that to keep ahead of rising electrical needs, UP & L has more than doubled its generating capability in the past 10 years to over 620,000 kw – and the end is not in sight!

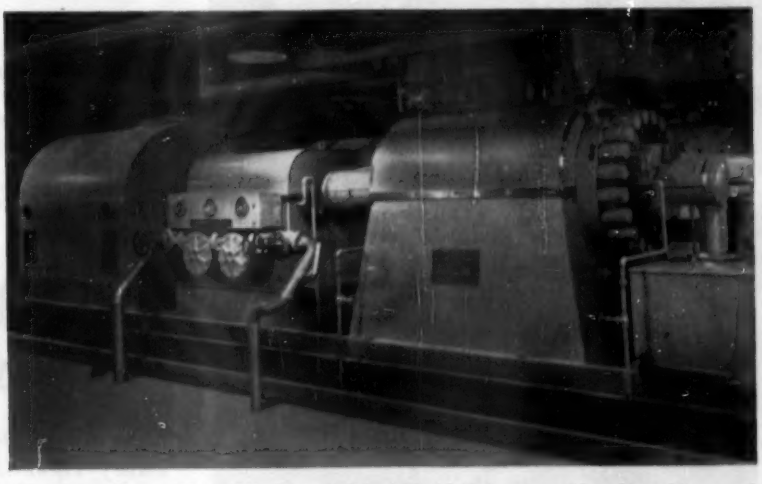
Costing upwards of $109 million, UP & L's new and improved electrical facilities include – at its Gadsby Plant – a new 100,000 kw steam-electric generating unit which utilizes the reheat cycle. As a part of this efficient operation, American Blower Sirocco Induced Draft Fans, Gyrol Fluid Drives, and Gas Recirculating Fan were selected.

The important part American Blower plays in UP & L's expansion program is being duplicated in dozens of other progressive, investor-owned companies. Utility men across the nation depend on American Blower Mechanical Draft Fans, Fly

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS &



Completed in June 1955, UP&L's new 100,000 kw No. 3 unit (left) boosts Gadsby Plant capability to 241,000 kw. The unit's two American Blower Sirocco Induced Draft Fans are each rated @ 260,000 cfm @ 325° F @ 15.5" sp @ 860 bhp. American Blower equipment is also installed on units No. 1 and No. 2.



American Blower Type VS, Class 6 Gyrol Fluid Drives provide adjustable speed control of boiler feed pumps at Gadsby Plant. Rating is 2500 hp @ 3600 rpm.

with the help of American Blower

Ash Precipitators, Dust Collectors, Heavy-Duty Steam Coils, and Gyrol Fluid Drives for boiler feed pump and fan control. And so can *you!*

For whether your modernization or expansion calls for indoor or outdoor installations, American Blower makes *your* problems *their* problems — and supplies air-handling equipment to meet your exact needs . . . to deliver peak performance continuously. To talk over your plans with an experienced representative, give your American Blower Branch Office a call.

AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
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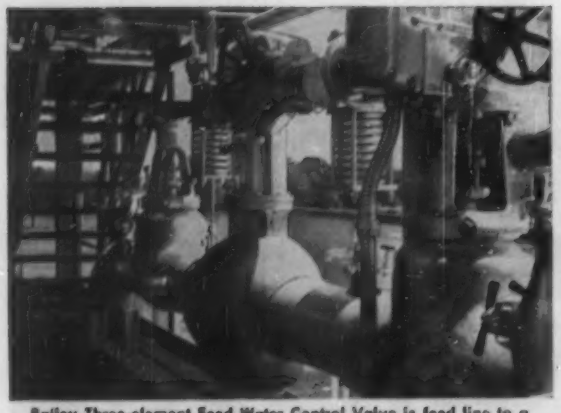
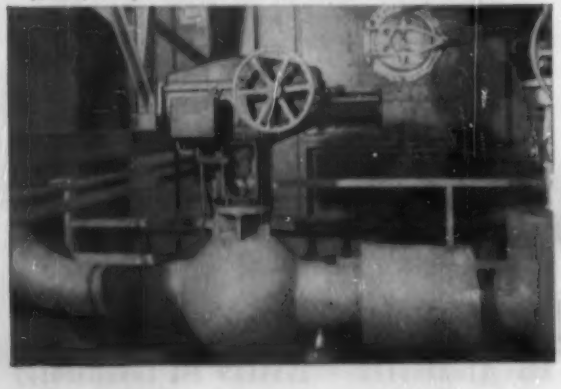


Bailey Three-element Feed Water Control Valve in feed line to a 450,000 lb per hour boiler.

Operator's station for Bailey Three-element Feed Water Control is located in this compact control room.

(Above) Bailey Boiler Control Panel for 750,000 lb per hour unit including Three-element Feed Water Control.

(Below) Bailey Control Valve in feed water line to above unit.



Here's Proof—

Bailey Is Your Best Buy in

More than 1000 large boiler units are equipped with Bailey Three-element* Feed Water Control for close regulation of drum level, added safety, and added efficiency.

That Bailey is better than a 2 to 1 favorite against the combined total of all other makes used in this service is borne out by checking the 173 steam-electric stations listed by Electrical World in its design issues of May 8, 1950 and April 7, 1952. No wonder we can say Bailey is your best buy.

Such an endorsement by users of power equipment doesn't just happen. It's the result of carefully weighing all factors: design superiority, accuracy of operation, dependability in service, and the experience of the

BAILEY METER

1036 IVANHOE ROAD

Complete Controls for

1000 times!

Feed Water Control

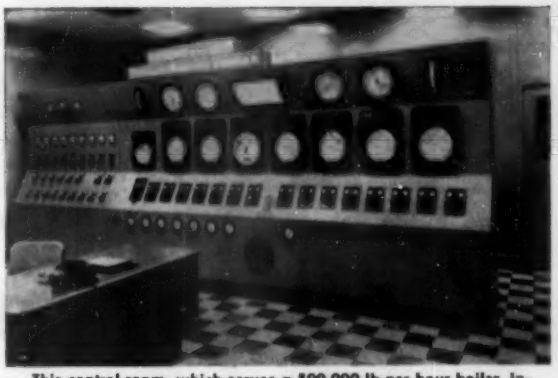
manufacturer in building and servicing this type of equipment.

That's why you should check with users before you buy. And you'll find a Bailey user near you. We couldn't spot over 1000 installations on one small map—but from those we were able to show, you can get some idea of Bailey's universal popularity—and how easy it is to get service with a minimum of travel time and expense. Call your nearest Bailey Office—they will be glad to arrange an inspection tour for you. And if you want catalog information, including a list of users, write for Bulletin 105-C Bailey Meter Company. A-123-2

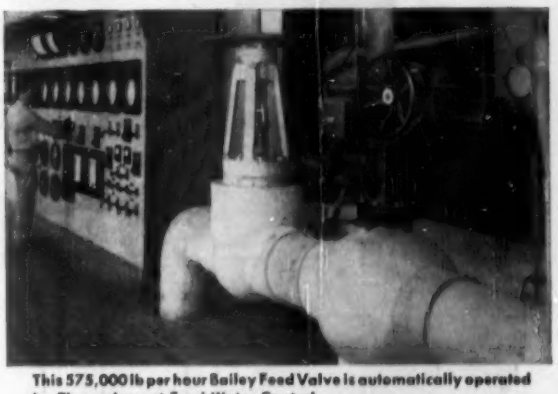
*The three elements are—1. Steam Flow from Boiler
2. Water Flow to Boiler
3. Water Level in Drum

COMPANY
CLEVELAND 10, OHIO
Steam Plants

COMBUSTION
FEED WATER
TEMPERATURE
PRESSURE
LIQUID LEVEL
FEED PUMPS



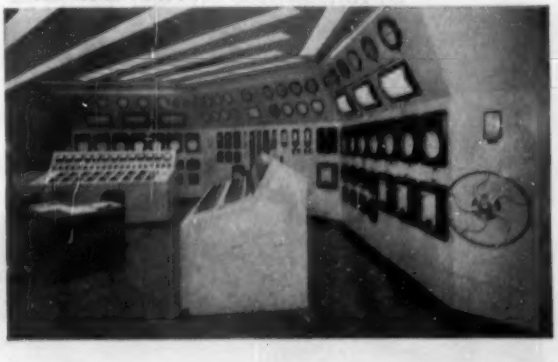
This control room, which serves a 500,000 lb per hour boiler, includes an operator's station for Bailey Three-element Feed Water Control.



This 575,000 lb per hour Bailey Feed Valve is automatically operated by Three-element Feed Water Control.

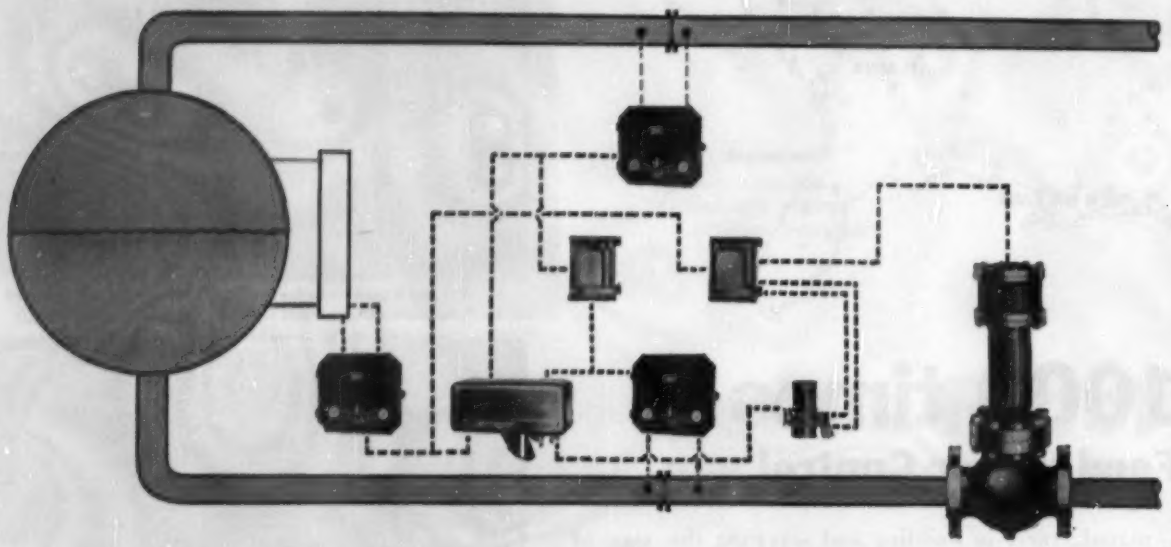
(Above) Operators' stations for Bailey Three-element Feed Water Control are concentrated in this centralized control room for three 250,000 lb per hour boilers.

(Below) Three-element Feed Water Control is part of the complete Bailey Control System operating two 500,000 lb per hour boilers from this control room.



NEW! COPES offers a choice of

. . . **WITH** **RECORDING INSTRUMENTS**



From the oldest comes the newest in three-influence feed water control—Copes Type 3-L with Taylor instruments. A minimum of instruments are required due to simplicity. Miniature recorders are indicated above. Standard size recorders may also be used to supply as many as four records on one chart. Each component of the Type 3-L system is selected for its accuracy and high quality. Each installation is backed by nationwide service, whenever or wherever required, for its entire life.

Copes three-influence control may also be actuated mechanically or electrically

COPES

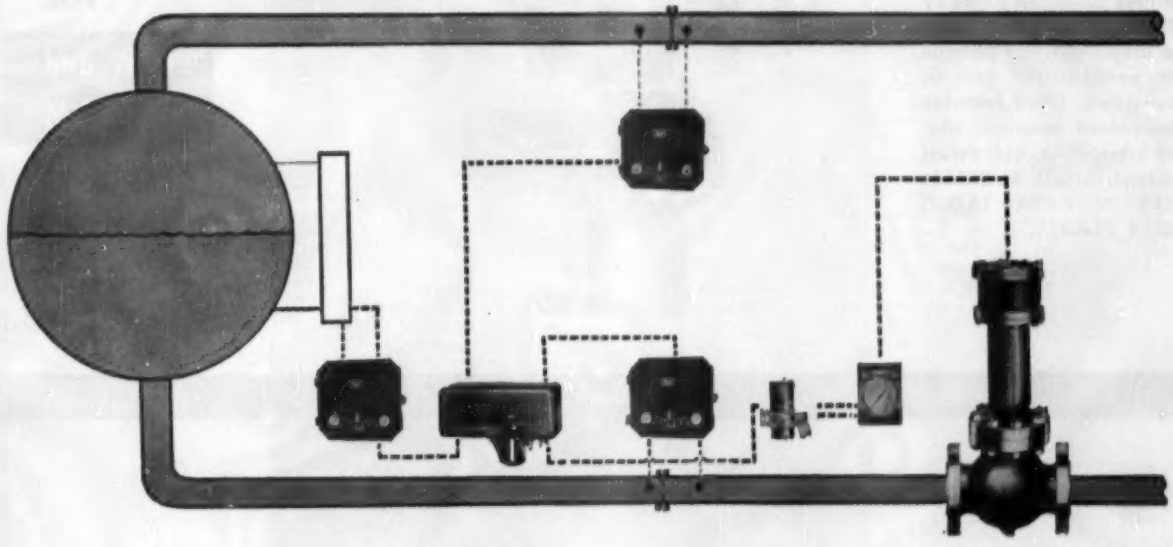
First to develop continuous

BOILER FEED

TYPE 3-L SYSTEM

3-influence controls

. . . **WITHOUT** RECORDING INSTRUMENTS



To further simplify a 3-L system, recorders may be omitted. The schematic shown above is the simplest instrument-type Copes three-influence feed water control system that is available. Ask for Bulletin 103-A which describes the combinations available in Type 3-L feed regulation.

COPES-VULCAN DIVISION

CONTINENTAL FOUNDRY & MACHINE COMPANY

ERIE 4, PENNSYLVANIA

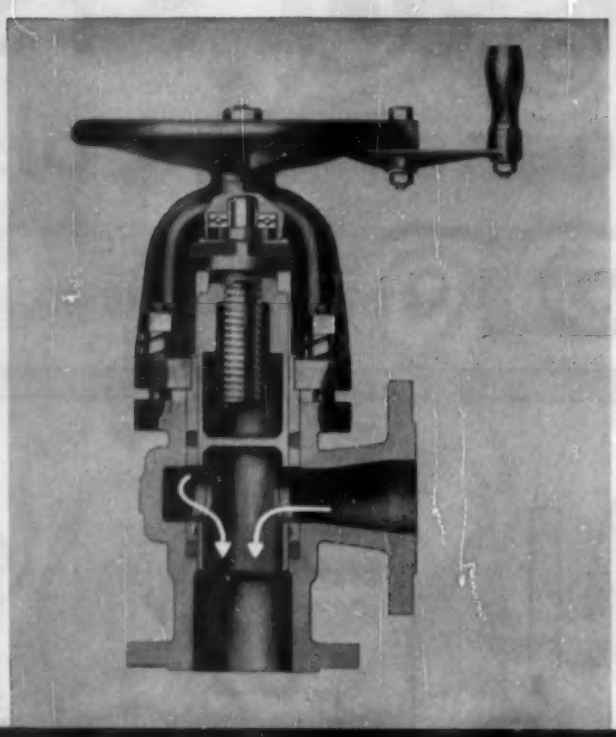
boiler feeding under automatic control

WATER REGULATION

These YARWAY VALVE DESIGNS

YARWAY SEATLESS

Features balanced nitralloy hollow plunger that seals line drop-tight, yet permits free, unobstructed flow in blow-down. Other features—laminated packing, alemite lubrication, ball thrust bearings. USED SUCCESSFULLY IN OVER 15,000 BOILER PLANTS.



FOR LOW and MEDIUM PRESSURES

YARWAY HARD-SEAT

Features tough, stellite-faced and ground disc and seat ring, mated to provide smooth long-wearing surfaces. Stream-line flow. Alemite lubrication. MORE THAN 4 OUT OF 5 HIGH PRESSURE BOILER PLANTS USE YARWAY BLOW-OFF VALVES.

FOR HIGHER PRESSURES

USED IN OVER 15,000 BOILER PLANTS

serve every boiler blow-down need

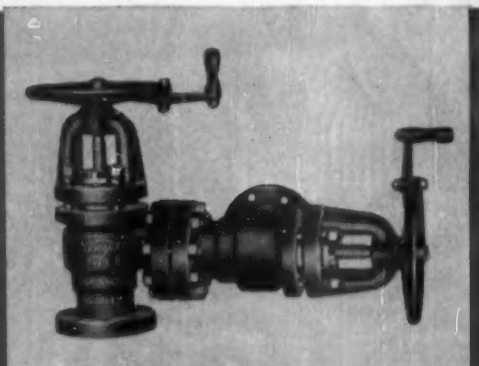
■ Whatever your *pressure* requirement, whatever your *piping* requirement—there's a Yarway Blow-Off Valve to exactly meet your needs.

Popular Yarway *seatless* design keeps blow-down lines drop-tight in low and medium pressure ranges. Sturdy Yarway *stellite seat and disc* design protects higher pressures.

All Yarway Blow-Off Valves are strong, rugged valves, built to withstand the punishment of regular or emergency blowing-down under full boiler pressure, and are available in metals that stand up under acid washing of boilers.

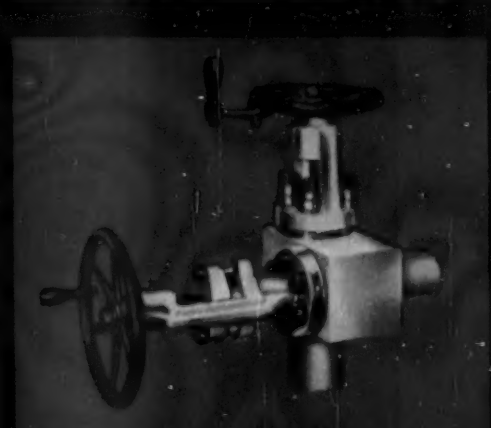
Write for new Yarway Blow-Off Valve Bulletins—B-426 (pressures to 400 psi) or B-434 (pressures to 2500 psi).

• Yarway Type B Seatless Blow-Off Valve, iron body for boiler pressures to 200 psi, steel bodies, for pressures to 400 psi. Angle valve shown, straightway available. Flanged connections. See Bulletin B-426.



• Yarway Type B Seatless Tandem Blow-Off Valve combining two angle valves. Other combinations available. Iron bodies for boiler pressures to 200 psi, steel bodies for pressures to 400 psi. See Bulletin B-426.

• Yarway Type C Seatless Tandem Blow-Off Valve combining angle and straightway valves. Other combinations available. Flanged or welding connections available. For boiler pressures to 600 psi. NOTE: When used in tandem with a Yarway Hard-Seat Valve, Type C Seatless may be used to 1500 psi. See Bulletin B-434.



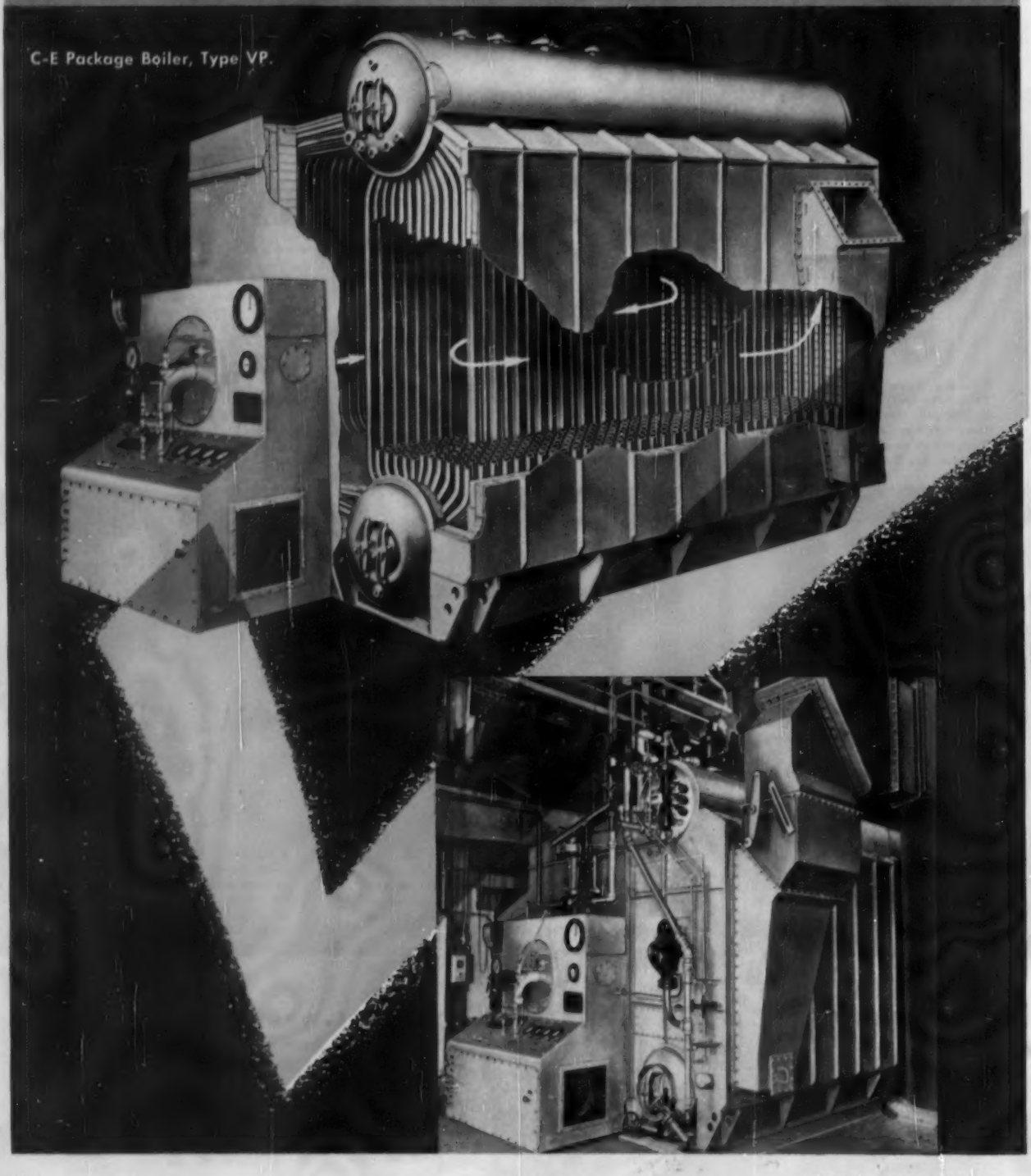
LET YARWAY HELP SOLVE YOUR BOILER BLOW-DOWN PROBLEMS!

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY

blow-off valves

BEFORE YOU BUY A PACKAGE BOILER . . .



C-E Package Boiler, Type VP.

CHECK THIS LIST!

	BOILER A		B		C	
	Yes	No	Yes	No	Yes	No
Will your boiler be a real "package" type with control panel and all controls mounted integral with the boiler?	☐	☐	☐	☐	☐	☐
Will your package boiler be equipped with drum internals to assure dry steam?	☐	☐	☐	☐	☐	☐
Will its "steam quality" be backed with a guarantee?	☐	☐	☐	☐	☐	☐
Will your boiler have a 30-in. lower drum to provide convenient accessibility?	☐	☐	☐	☐	☐	☐
Will yours be a one-burner boiler, with a simple wiring and control system?	☐	☐	☐	☐	☐	☐
Will your boiler have the largest load swing range available?	☐	☐	☐	☐	☐	☐
Will your boiler be equipped with a quiet centrifugal fan?	☐	☐	☐	☐	☐	☐
Will your furnace be *completely* water-cooled?	☐	☐	☐	☐	☐	☐
Will your furnace have the highest ratio of water cooled surface to furnace volume?	☐	☐	☐	☐	☐	☐

If you are in the market for a package boiler, this check list can provide you with some interesting answers. Of course C-E's Type VP Boiler rates a "yes" answer to every question. In addition it offers many other operational advantages such as simple, effective soot blowing; high heat absorption; low draft loss; no dead gas pockets and simple baffle arrangements.

Little wonder then that VP purchasers range from small companies to some of the largest in the country . . . industrials of all kinds . . . schools and institutions . . . various government agencies . . . including the Atomic Energy Commission. These users are employing VP Boilers for all types of applications — heating, process, and even power generation.

SPECIFICATIONS
of the VP Boiler

Capacity — 4,000 to 40,000 pounds of steam per hour

Pressures — up to 500 pounds per square inch

Fuel — oil or gas

Erection — completely shop-assembled

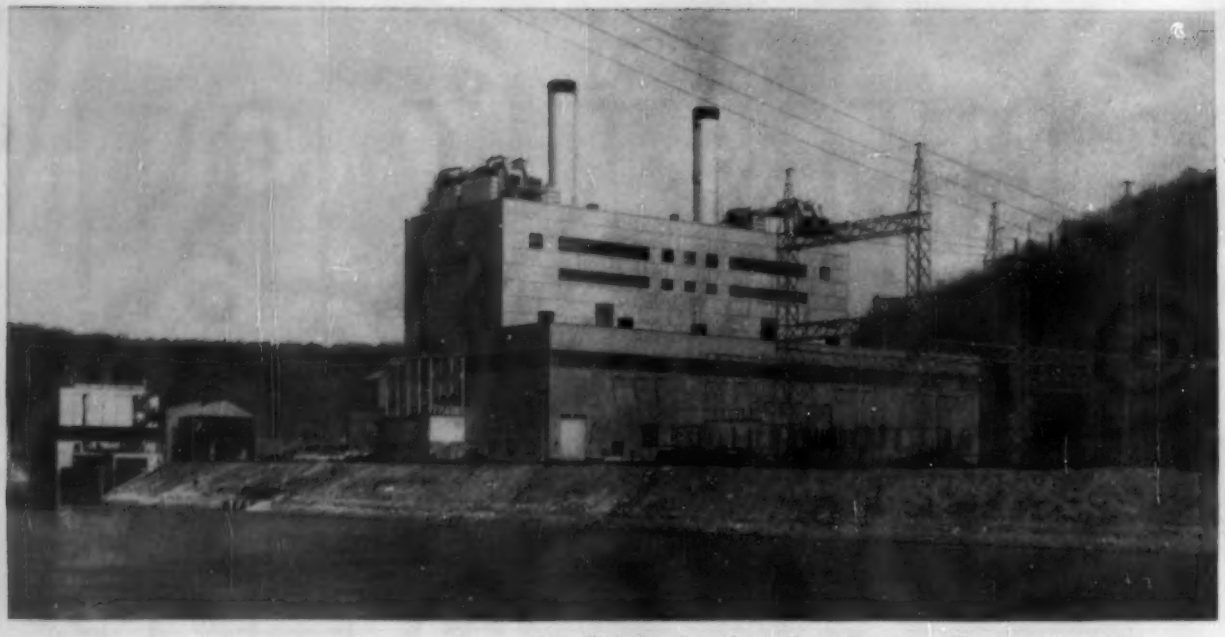
Foundation — simple concrete slab

Make sure that you have details of the VP at your fingertips when you are in the market for a boiler of moderate capacity. Ask for the new Catalog VP-108, which contains specifications and general information on dimensions, construction details and controls. B-845

COMBUSTION ENGINEERING

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

BOILERS, FUEL BURNING & RELATED EQUIPMENT; PULVERIZERS, AIR SEPARATORS & FLASH DRYING SYSTEMS; PRESSURE VESSELS; AUTOMATIC WATER HEATERS; SOIL PIPE



Shawville Station, Pennsylvania Electric Company — Gilbert Associates, Engineers. Boiler plant consists of two 894,000 lbs. per hour coal fired reheat units operating at 1900 psig and 1055°F/1005°F.

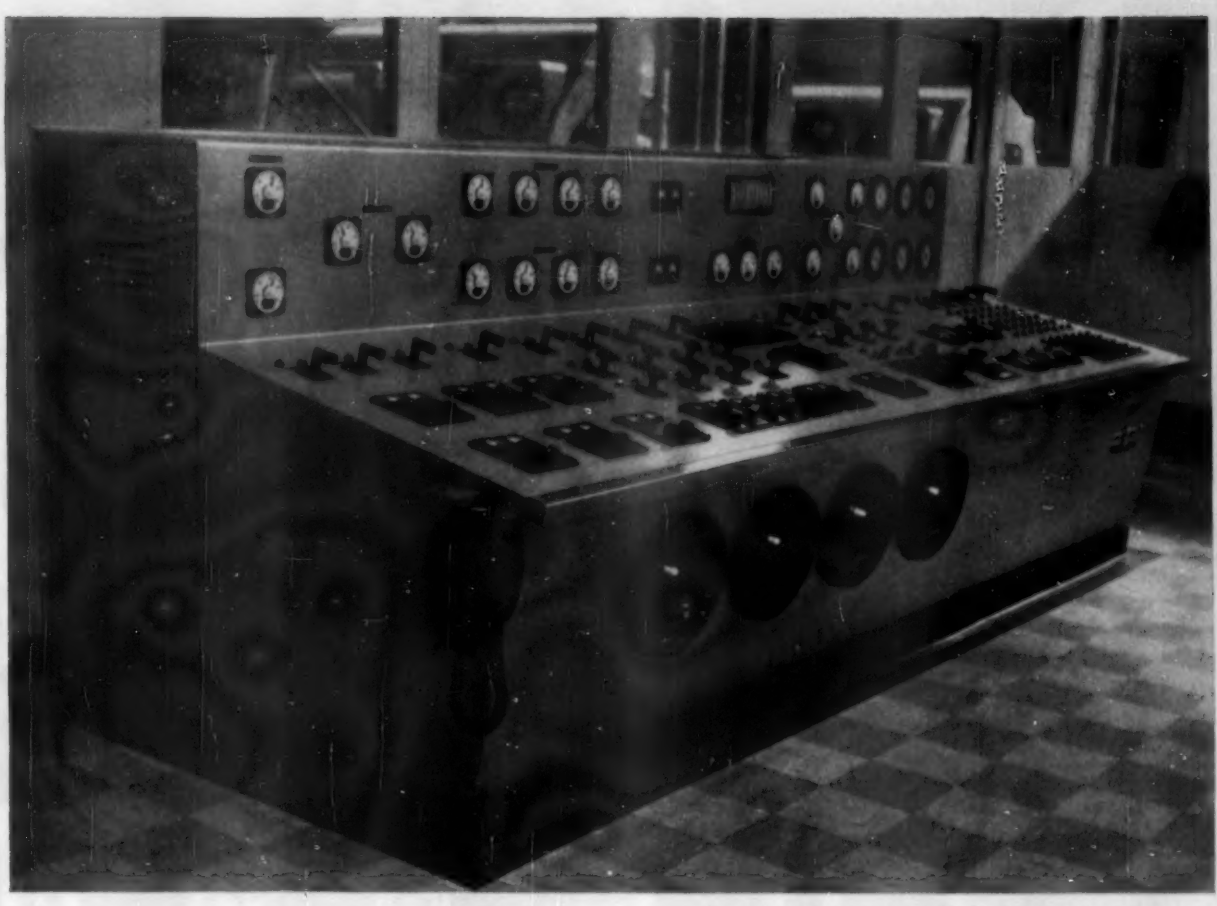
SHAWVILLE
Controls Steam Costs *Electronically*

At Pennsylvania Electric's new central station near Clearfield, Pa., Republic Electronic Combustion Controls instantaneously correct the firing rate when load changes *first* occur — minimize the effect of load swings almost to the vanishing point —simplify feedwater and steam temperature control—eliminate practically all mechanical inertia, friction and lost motion in master control apparatus—transmit control signals with the speed of light—permit more compact, easier-to-operate control panels.

These electronic combustion control features are paying off in lower steam costs for Shawville. In fact, this station produces steam at such low cost that it is able to compete successfully in out-of-state areas over 250 miles away.

At Shawville, electronic circuits instead of pneumatic and mechanical assemblies generate control impulses which are sent to pneumatically powered regulators on boiler auxiliaries. Dead spots and time lags in the master control system due to mechanical lost motion, friction and inertia are almost completely eliminated. And control impulses are transmitted practically instantaneously, thanks again to the speed of electronics.

REPUBLIC FLOW METERS CO.



Electronic combustion controls for Unit No. 2 at Shawville are centralized on this benchboard.

The master impulse for the combustion control system is derived from steam flow. Air flow to the boiler is directly controlled by this impulse. The signal is then modulated by pressure changes in the steam header and sent to coal mills. Variations in the fuel are automatically compensated for. If steam flow falls below or exceeds pre-set limits, the steam flow-air flow control system is automatically blocked out and conventional fuel flow-air flow control substituted.

This control system compensates for load changes so quickly that their effect on boiler operation is practically nullified. Optimum fuel-air ratio is maintained continuously for maximum combustion efficiency. The feedwater system and superheater temperatures are also stabilized, making these quantities easier to control.

REPUBLIC

Automatic

COMBUSTION CONTROLS

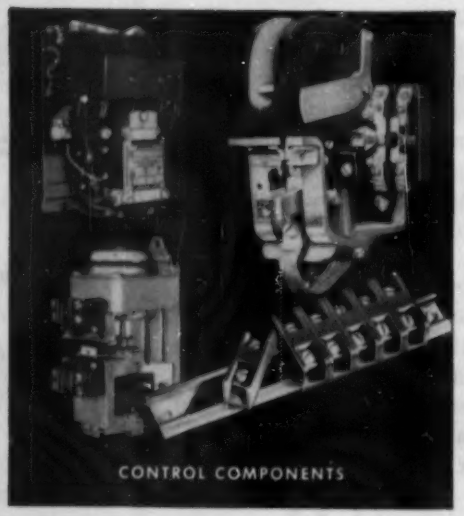
(Pneumatic or Electronic)

★ **for all sizes and types of boilers**
★ **for all methods of fuel firing**
★ **for all load conditions**
★ **for all arrangements of draft**

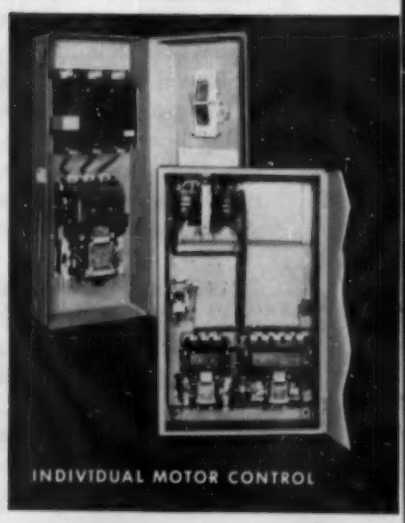
Write for full details

2240 Diversey Parkway • Chicago 47, Illinois

MOTOR CONTROL FACTS ON
INDUSTRY'S MOST COMPLETE LINE



CONTROL COMPONENTS



INDIVIDUAL MOTOR CONTROL

FACT:

The only manual reduced voltage starter with air break contacts in all ratings

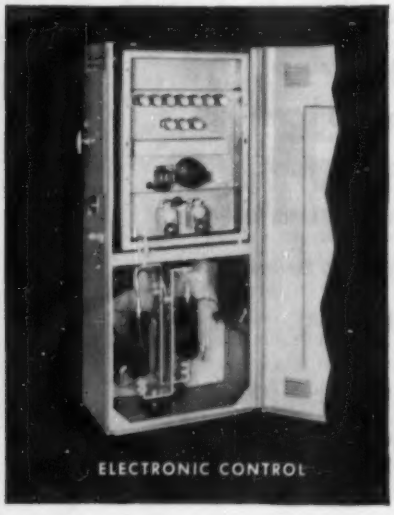
The new Westinghouse Type MB autostarter with air break double contacts eliminates the costly "oil problems" of contamination, oil level checks, spilling and messy leaking. This combined with timed acceleration makes it industry's most advanced reduced voltage starter.

Such product design advances are just part of the total advantages you gain with Westinghouse motor control. *Whatever your control problem* —from the simplest control component to complete automation—it can be solved all from *one* source—*one* responsibility.

For *all* the facts on Westinghouse motor control, call your Westinghouse sales engineer . . . *The Man With The Facts!* J-21872

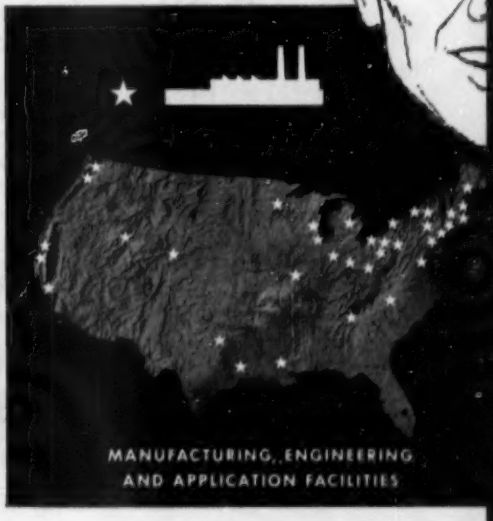
YOU CAN BE SURE... IF IT'S

Westinghouse



ELECTRONIC CONTROL

CONTROL SYSTEMS

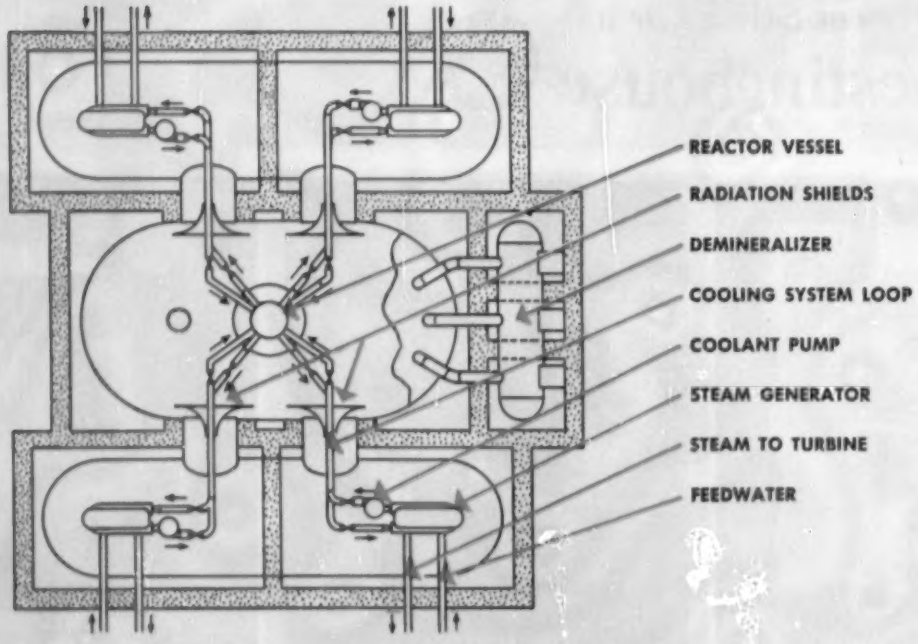


MANUFACTURING, ENGINEERING AND APPLICATION FACILITIES

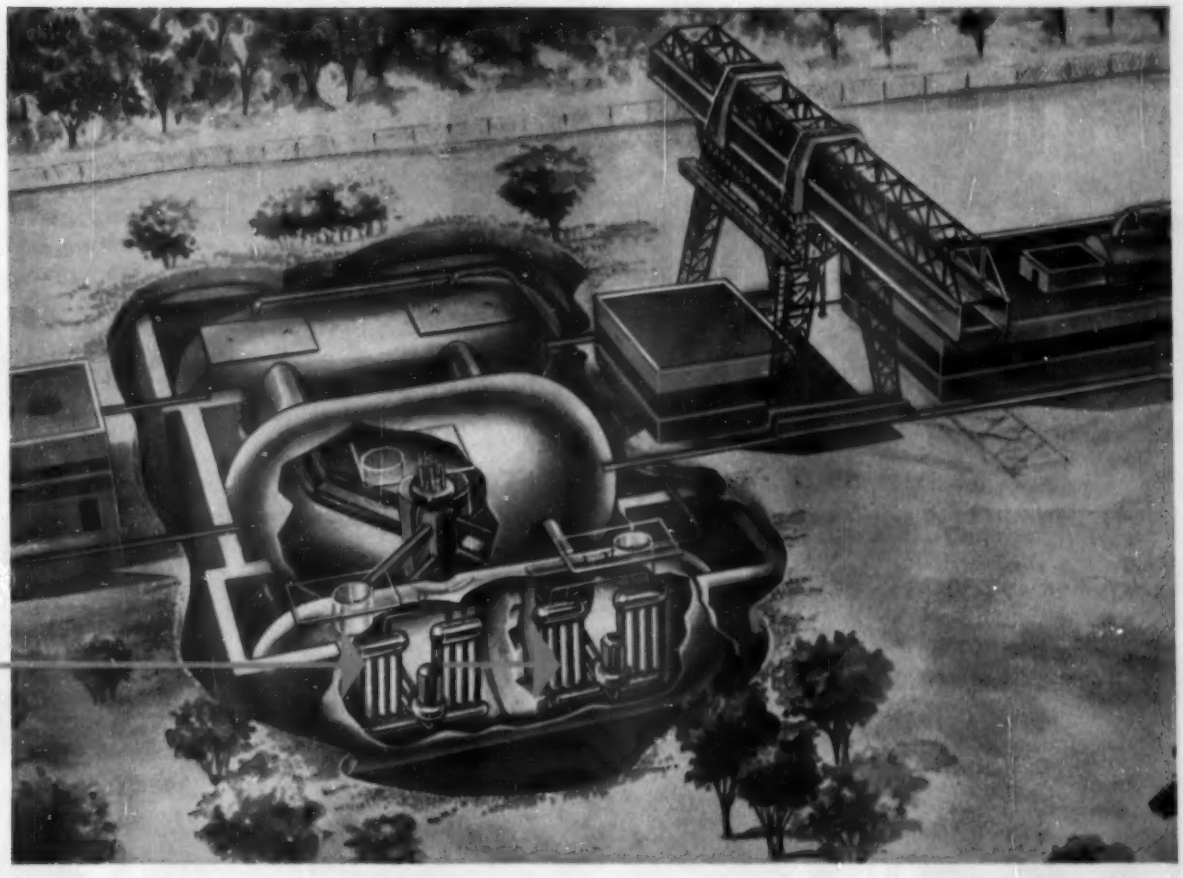
in nation's first full-scale

Atomic Power Plant

Foster Wheeler steam generators will help convert nuclear energy into kilowatts



Schematic plan view of nuclear reactor and steam generator sections of the Duquesne Light Company's atomic power station, now under construction at Shippingport, Pa.



Pressurized water reactor power station at Shippingport marks historic milestone in the generation of electric power

THE atomic power plant of the future is a dream no longer. Ground has been broken and construction is now under way!

Here at Shippingport, Pa., the Atomic Energy Commission and the Duquesne Light Company are cooperating in a joint project, erecting the nation's first full-scale atomic power generating station. This nuclear power plant will make an historic contribution to the entire electrical industry.

The nuclear reactor portion of the plant which is being built for the AEC by Westinghouse Electric Corporation will be located underground in huge, shielded steel shells as shown in the artist's sketch above. The steam generators (heat exchangers) will convert heat from the reactor to 600 psia steam for driving the turbo-generator.

In designing and building two of the four steam generators for this first commercial atomic power plant, Foster Wheeler will bring to bear a wealth of practical experience in the nuclear power field. Since the administration of the Manhattan District, wartime predecessor of the AEC, Foster Wheeler has been actively engaged in atomic energy work. FW nuclear power heat exchangers are installed at the National Reactor Testing Station, the Knolls Atomic Power Laboratory, and on board the U.SS. "Nautilus"—first atomic power submarine.

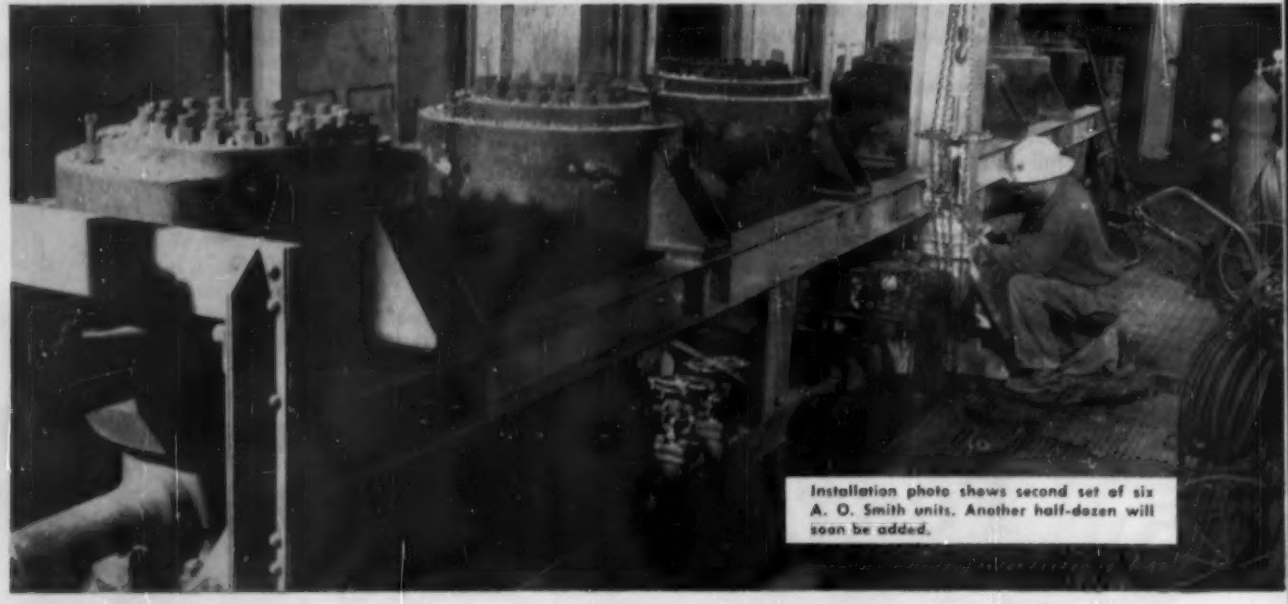
In conventional or atomic power plants, heat engineering by Foster Wheeler means efficient and dependable steam generation at low overall cost. For the latest Nuclear Forecast and information on a low-cost Nuclear Power Plant, write for HE-5-55. *Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.*

FOSTER WHEELER

LONDON • NEW YORK • PARIS • ST. CATHARINES, ONT.

Third set of A. O. Smith Feed Water Heaters ordered by Wisconsin Electric Power Company

Here's the first set of six A. O. Smith Feed Water Heaters working for Wisconsin Electric Power Company.



Installation photo shows second set of six A. O. Smith units. Another half-dozen will soon be added.

The Oak Creek plant, pictured here, is located on the shores of Lake Michigan near Milwaukee.

A. O. SMITH is proud to be associated with Wisconsin Electric Power Company's Oak Creek plant — Wisconsin's largest. The new features designed into these steam turbine generator units make it one of the country's most modern plants.

Now on the job at Oak Creek are two sets of six A. O. Smith Feed Water Heaters. These will soon be augmented by another bank of six . . . each bank designed with desuperheating and drain cooling sections.

These A. O. Smith units are built for operating pressures of 2,400-2500 psi. End closure and channel test out at 4,800 psi. Inside diameter is 24 inches, while overall lengths are up to 23 feet.

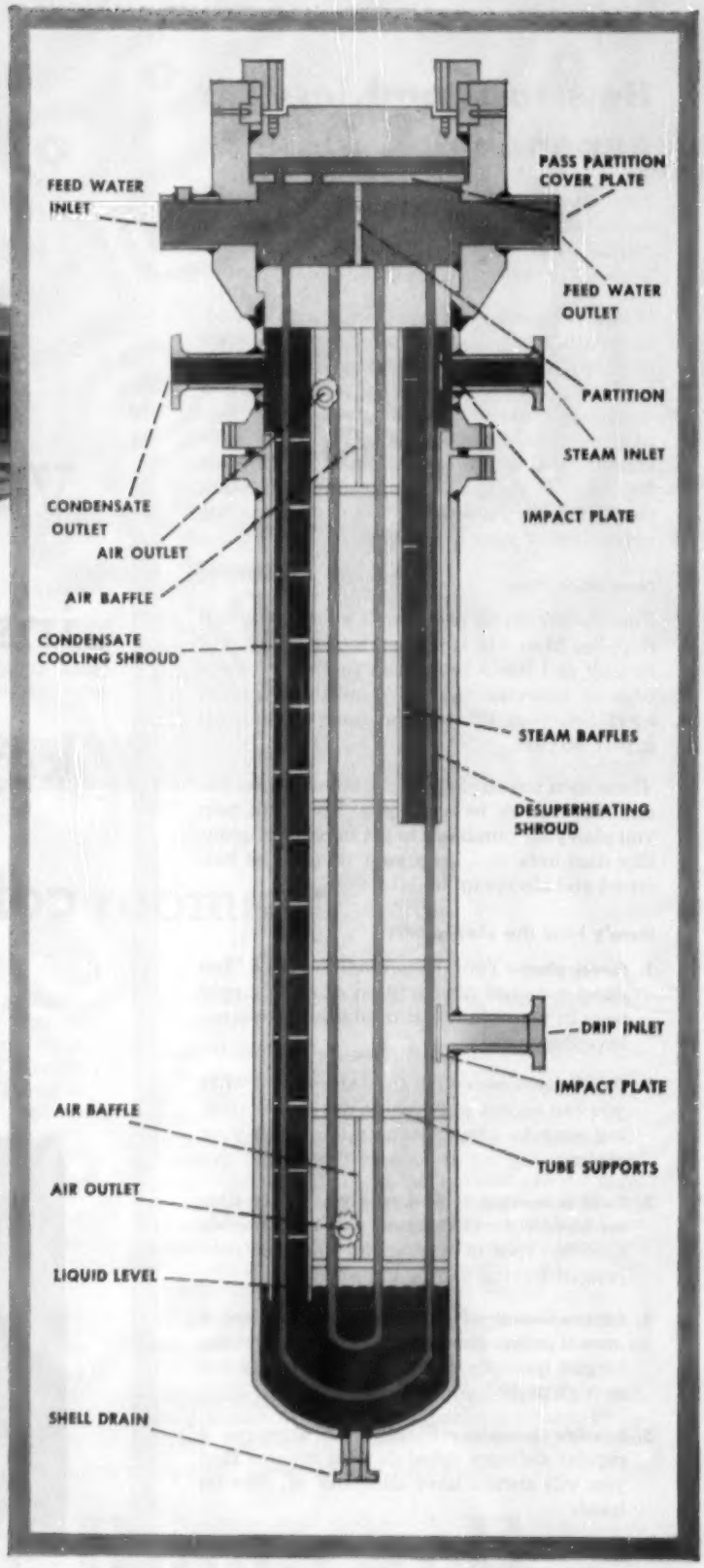
Exchanger designs, proved through years of service, make specifications of 1,000 to 10,000 psi *standard* in our exchanger and vessel shops. *Special* heat transfer problems, too, can be solved best by A. O. Smith, because our thermal design group is recognized as one of the finest in the country. You'll profit most by contacting A. O. Smith first.

SEND TODAY for new informative booklet describing A. O. Smith Feed Water Heaters in detail.

Through research ...*a better way*

A.O.Smith
CORPORATION

PROCESS EQUIPMENT DIVISION
Milwaukee 1, Wisconsin
International Division: Milwaukee 1



Cutaway drawing shows a Feed Water Heater of the type used by Wisconsin Electric Power Company.

How to spend less for expendables

Day after day, week after week, your instruments steadily use up charts, inks, thermocouple wires, tubes, wells—all the expendable accessories that require regular replacement.

If you've been buying your supplies on a hand-to-mouth basis, you're missing out on some sizable savings. Honeywell has developed a modern purchasing plan that gives you new economy, convenience, and quality. This new plan provides assistance in selecting the right supplies and sets up a custom-fitted schedule for buying that will cut your inventories, simplify your purchasing, and save you a big percentage of your annual bill.

New HSM Plan

Foundation of this new plan is your Honeywell Supplies Man. He is trained in the Honeywell factory and has a broad and thorough knowledge of instrumentation. A full-time supplies specialist, your HSM gives you personalized, expert service.

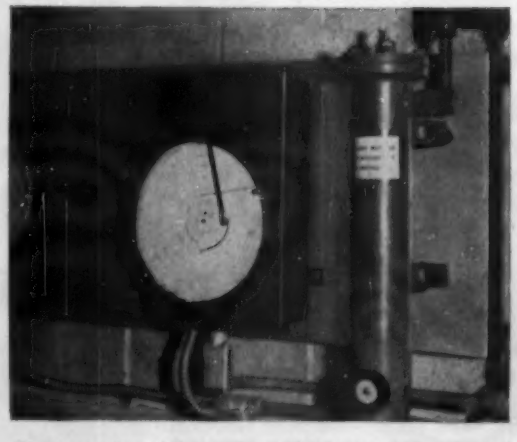
These men are strategically stationed throughout the country to serve you. They will help you plan your purchases to get maximum quantity discounts . . . keep your inventories balanced and always up to date.

Here's how the plan works

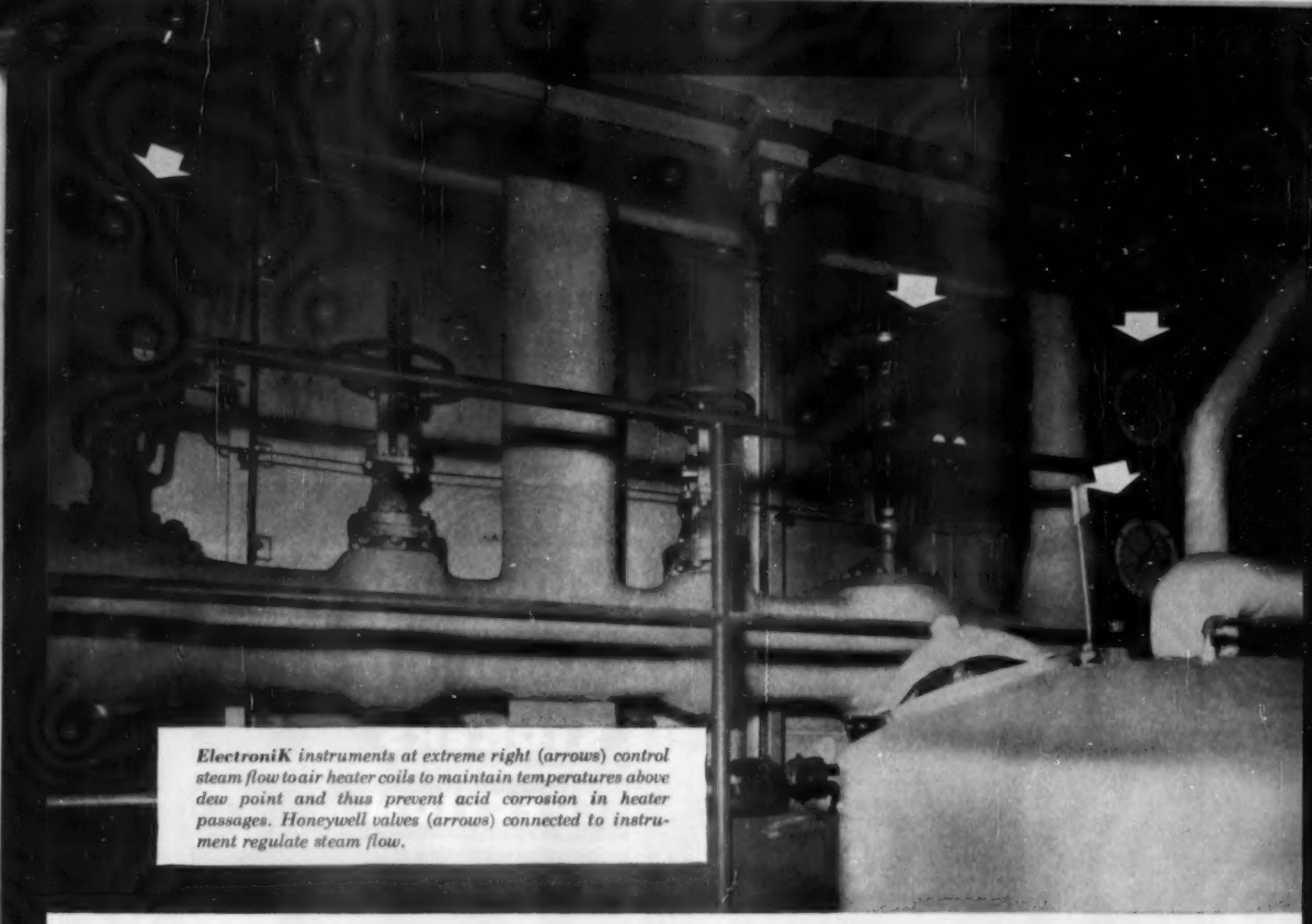
1. ***Survey plant***—Your Honeywell Supplies Man checks annual consumption of each supply item in your plant and establishes minimum inventory needs.
2. ***Detail requirements***—He then shows you what you can expect to purchase during the coming year to keep adequate stocks on your shelves.
3. ***Assist in selection***—He keeps you up to date on newest developments, and recommends specific types of equipment wherever your present buying can be improved.
4. ***Estimate savings***—Next, he prepares a blanket annual order, grouping like items to get the biggest quantity discount. Savings may run as high as 50%.
5. ***Schedule deliveries***—Finally, he arranges a regular delivery schedule that assures that you will always have adequate supplies on hand.

Give your Honeywell Supplies Man a call. He's at your local Honeywell office . . . as near as your phone.

Versatile Brown instrumentation—key to efficient control of critical



Evenly graduated flow meter, with its meter body mounted next to it, integrates and records flow of softened water to evaporators.



ElectroniK instruments at extreme right (arrows) control steam flow to air heater coils to maintain temperatures above dew point and thus prevent acid corrosion in heater passages. Honeywell valves (arrows) connected to instrument regulate steam flow.

variables in boiler rooms

WHEN YOU'RE planning new capacity or modernizing present installations, it will pay you to take a look at what Brown instrumentation can do in your boiler room. The two examples pictured here, at the Martin's Creek Station of Pennsylvania Power & Light, demonstrate just a few of the many applications where this modern line of precision equipment can be advantageously applied.

Anti-Corrosion Air Heater Control, a pair of *ElectroniK* potentiometers measure average cold end temperatures and regulate steam flow so as to maintain flue gas consistently above the dew point. This system prevents condensation and resulting sulfuric acid corrosion in the air heaters.

Guide for Efficient Operation for Feedwater, a Brown Flow Meter with evenly graduated scale records and integrates the flow of softened water to the evaporator to guide operators. The evenly graduated scale gives excellent readability across the entire chart. Fast electronic integration adds up total flow with exceptional accuracy.

Critical Variables—Also included in the Brown line are numerous other types of instruments for measuring, recording and controlling temperature, flow, conductivity, liquid level, pH and pressure . . . electric and pneumatic remote transmission systems . . . miniature *Tel-O-Set* instruments for graphic panel boards, and control valves. All are made to the highest standards of performance and dependability by the world's largest manufacturer of controls. All are backed by the nationwide facilities of the Honeywell service organization . . . ready to serve you promptly and effectively from offices close at hand.

Ask your local Honeywell sales engineer to discuss your particular plant control problems . . . he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.—in Canada, Toronto 17, Ontario.

● **REFERENCE DATA: Write for Catalog 2320, "Flow Meters" . . . and for Catalog 9050, "Instrumentation for Steam Plants."**

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS
First in Controls

ERIE CITY

manufactures all major co
of their STEAM GENERATORS off
responsibility for

- BOILERS
- SUPERHEATERS
- AIR HEATERS
- STOKERS
- ERECTION
- SERVICE

Investigate the advantages obtained through the purchase of complete, modern, steam generators by Erie City Iron Works. No division of responsibility—one manufacturer builds all the component parts—each part designed and engineered for maximum efficiency—all erected and serviced by Erie City under one contract.

When fuel and boiler room labor costs affect your competitive position, when steam demands crowd old boilers to the dangerous limit, it is time to consider the advantages obtained by using steam generators designed and built by Erie City Iron Works. Bulletin SB-50 describes the complete line of power equipment.

ERIE CITY
115 Years In Steam Generation

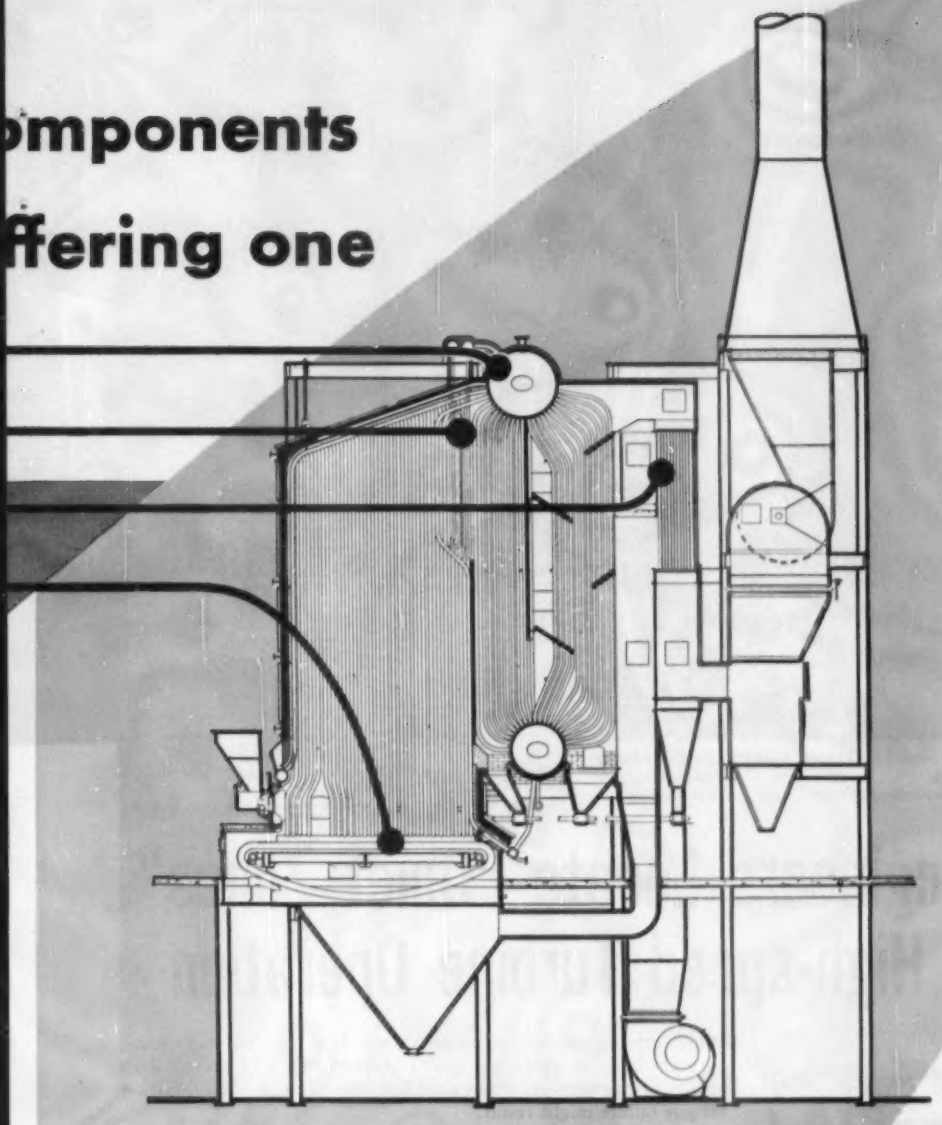
You can depend on Erie City for sound engineering

ERIE CITY IRON WORKS • *Erie, Pa.*

STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS
UNDERFEED AND SPREADER STOKERS • PULVERIZERS

omponents

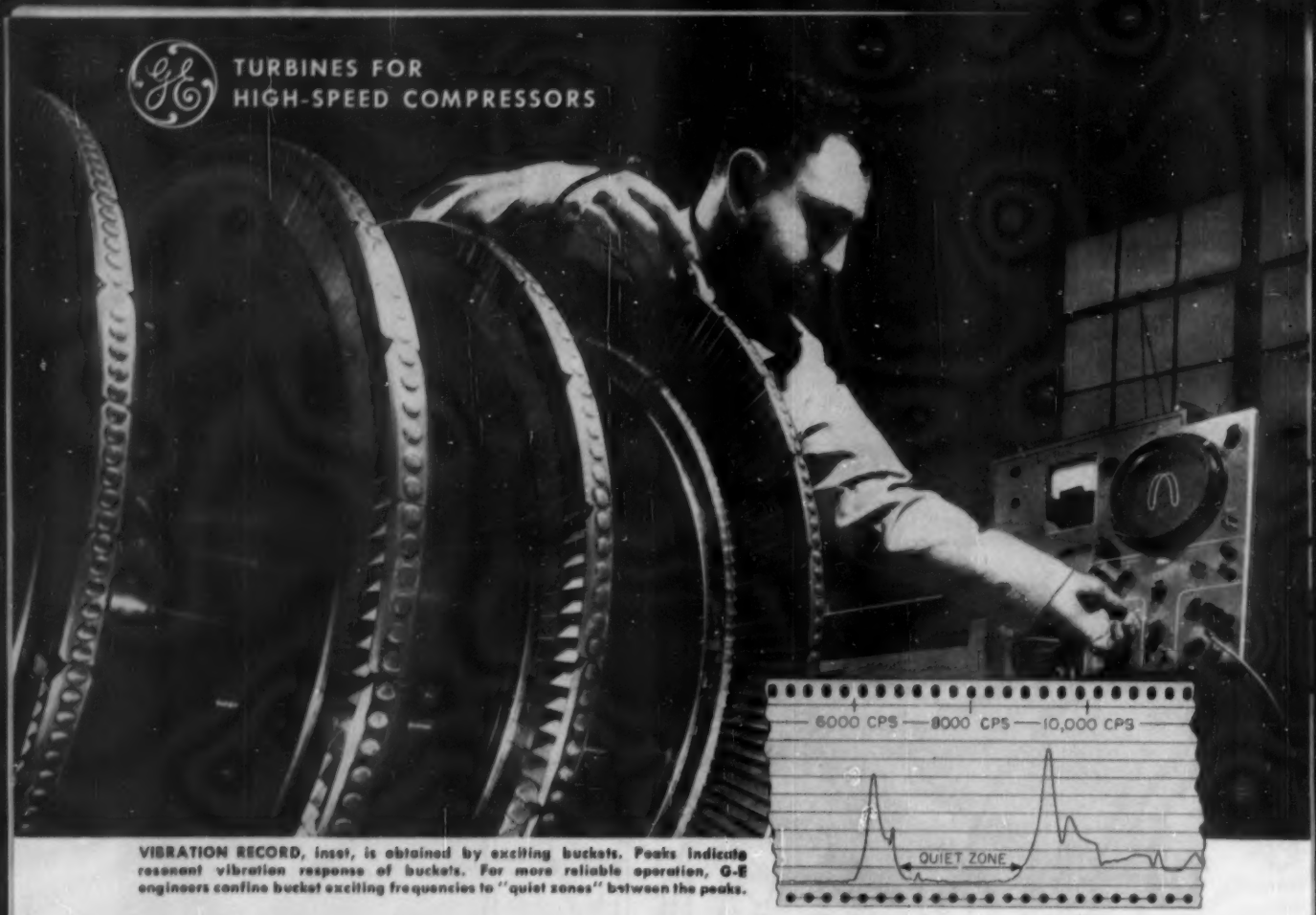
ffering one



Three Steam Generators with

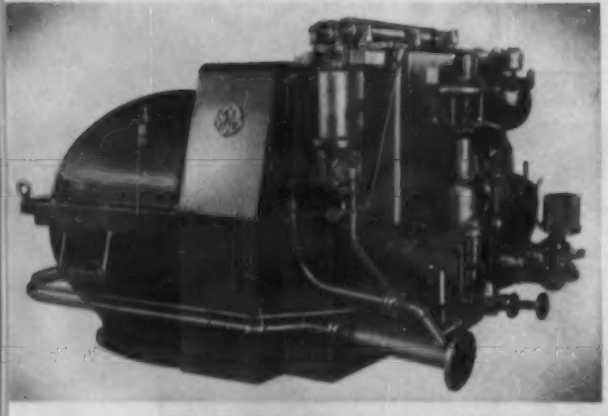
- Erie City 100,000 lbs. per hour 2-Drum Boilers
- Erie City Single Pass Tubular Air Heaters
- Erie City "Travagrate" Continuous Ash Discharge Spreader Stokers
- Erie City Pendant Type Superheaters

TURBINES FOR
HIGH-SPEED COMPRESSORS



VIBRATION RECORD, inset, is obtained by exciting buckets. Peaks indicate resonant vibration response of buckets. For more reliable operation, G-E engineers confine bucket exciting frequencies to "quiet zones" between the peaks.

How G-E Engineers Locate "Quiet Zones" for Safer High-speed Turbine Operation



TYPE DRV HIGH-SPEED MECHANICAL-DRIVE TURBINE

When driving modern compressors and blowers, G-E high-speed turbines spin at operating speeds of 7000 rpm and up. At such speeds, if resonant vibration were not controlled carefully, bucket fatigue failure might result.

HERE'S HOW General Electric combats the problem: Natural vibration frequencies of the buckets on each new turbine rotor are determined with the special equipment shown above—an oscillator, crystal pick-up, and high-speed level recorder. "Quiet zones" of minimum normal vibration are clearly revealed.

With this information available, the number of nozzles can be varied so that steam striking the buckets will create vibration-exciting frequencies only in these "quiet zones." By thus making sure that steam-impact frequencies don't coincide with critical natural frequencies, the chance of bucket failure is greatly reduced.

VIBRATION TESTING is one of many features that add to the reliability of G-E high-speed turbines. For more information, contact your nearest G-E Apparatus Sales Office or write General Electric Company, Schenectady 5, N. Y. 241-2

Progress Is Our Most Important Product

GENERAL ELECTRIC

Kidney for an Atomic Fish

Something the Nautilus, U. S. Navy atomic-powered submarine, must have is chemically pure (ion-free) water. A "kidney" like the one shown above, with MONOBED® ion exchange resins as its innards, keeps water used free of even traces of dissolved salts.

What does this mean to you? It means that if you, too, require water of high quality, from a beaker-full to millions of gallons, for research work or for high-pressure boilers, for steam irons or for industrial processing, you can count on MONOBED ion exchange resins.

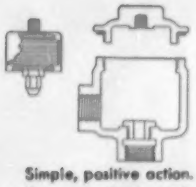
Suppose you don't need the ultimate in ion-free water? Then AMBERLITE® ion exchange resins in conventional deionization units may be the answer. AMBERLITE exchangers may be indicated when you want to soften, dealkalize, or deacidify water—when you want to replace or remove ions in solution . . . economically . . . efficiently.

Ask for "If You Use Water . . .", a 24-page booklet of basic information on the ion exchange treatment of water.

ROHM & HAAS COMPANY

THE RESINOUS PRODUCTS DIVISION, PHILADELPHIA 5, PENNSYLVANIA

Simplicity



Simple, positive action. Has only three parts —thermostatic bellows, body, cap. Won't leak!

Nicholson simplicity. Pays off big in steam distribution—in peak performance, easy maintenance. Simple in design, simple in operation, Nicholson Industrial Traps prove the most effective method for discharging condensate and air from steam lines.

- **Fast, intermittent valve action.**
- **Tight, positive shut-off.**
- **No dribbling. No waste of steam.**
- **Low operating cost. Low maintenance.**

Before you specify, check Nicholson. Write for *Catalog 953*.

NICHOLSON

W. H. NICHOLSON and Company

TRAPS • VALVES • FLOATS • METAL PARTITIONS

14 OREGON STREET, WILKES-BARRE, PA. • SALES AND ENGINEERING OFFICES IN 50 PRINCIPAL CITIES

Are you now using the most efficient coal for your purpose?

LET OUR TECHNICAL SERVICE ADVISE YOU!

No two plants are alike—design and equipment characteristics make the difference. That's why it's so important to consider *kind* and *size* when selecting a coal for your particular burning equipment. The B&O Technical Service is prepared to study your specific problem and help you choose the correct coal. Here's what our service does for you:

- outlines Bituminous coals available for your plant.
- discusses the merits of these coals.
- establishes current and predicts future relative values of these coals.
- determines the best coal for your system.
- suggests the most efficient way to burn this coal.
- supplies case histories of actual savings in fuel costs.

Ask our man! Write:
COAL TRAFFIC DEPARTMENT
BALTIMORE & OHIO RAILROAD
BALTIMORE 1, MARYLAND

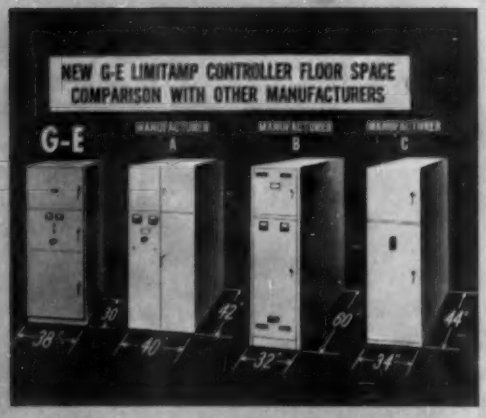
BITUMINOUS MEANS DEPENDABILITY!

Reserves will be available for centuries to come. Cost will remain low and stable thanks to modern mining practices.

Baltimore & Ohio Railroad

Constantly doing things—better!

BITUMINOUS COALS FOR EVERY PURPOSE



356 SQ. IN. LESS area than next smallest starter.

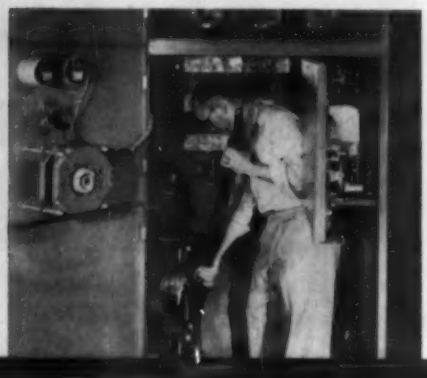
General Electric Announces . . .

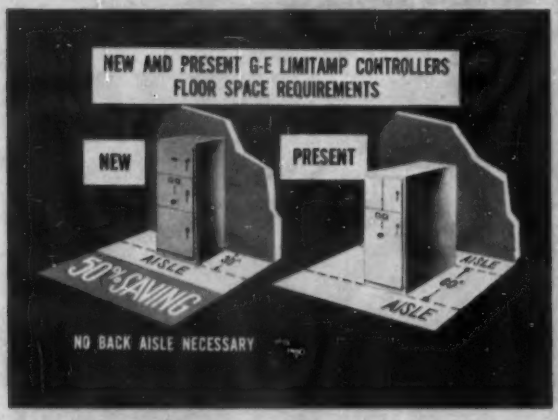
NEW Limitamp*

- **Gang-operated disconnect switch on all units**
- **Entirely front connected**
- **30-inch depth**
- **Low-voltage panel hinged to swing out of enclosure**
- **Contactor rolls in or out of cabinet**

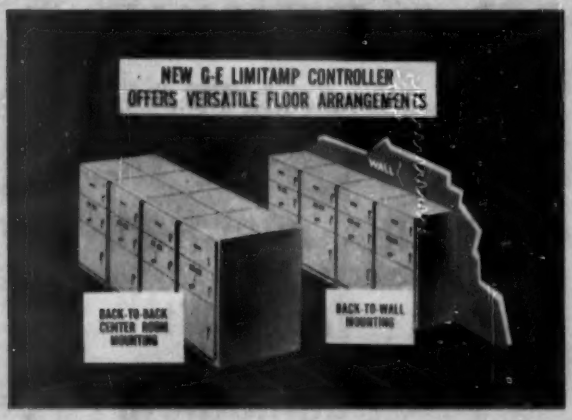
NEW DESIGN

INSTALLATION IS SIMPLIFIED. A man can easily enter enclosure to make connections.





OVER 50% SPACE SAVINGS by elimination of back-aisle.



VERSATILE INSTALLATION—units all front connected.

Control saves over 50% floor space

ENTIRELY FRONT CONNECTED, only 30 inches deep, General Electric's all-new Limitamp control offers versatility of installation. New 30-inch depth allows unit to be transported through normal size doorways, and 90-inch height includes bus compartment. Back-to-back, back-to-wall, or mounting as free standing enclosure is now possible.

IDEAL FOR HIGH-VOLTAGE MOTORS, rated 2300-4800 volts and up to 3000 h-p, the new Limitamp control may be applied to squirrel-cage, synchronous, wound-rotor, and multi-speed motors on power systems requiring high interrupting capacity for maximum short-circuit protection.

NEW CONCEPTS IN SAFETY are built into new Limitamp control. Gang-operated disconnect switch, steel barriers between all compartments, enclosed bus compartment and co-ordination of starter assure you of safer high-voltage motor control.

G.E. LIMITAMP STARTERS are co-ordinated to provide maximum protection for equipment and personnel. Co-ordinated circuit components guard against needless fuse blowing, give running overload protection and provide maximum safe-guard against short-circuit damage for starter and equipment.

FOR COMPLETE APPLICATION ENGINEERING service contact your nearest G-E Apparatus Sales office. Write for Bulletin GEA-6331, Section 781-12, General Electric Co., Schenectady 5, New York.

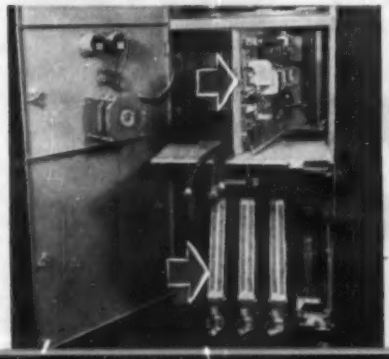
*Trade-mark of General Electric Company

Progress Is Our Most Important Product

GENERAL ELECTRIC

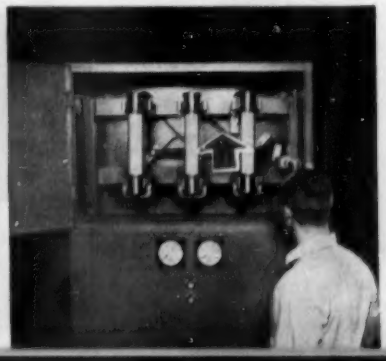
SIMPLIFIES INSTALLATION AND MAINTENANCE

MAINTENANCE IS EASY. Low-voltage panel swings out, contactor rolls out.



TYPE EJ-2 CURRENT-LIMITING fuses are safely, quickly replaced within seconds.

SAFE VISUAL CHECK of disconnect switch with fuse compartment door open.



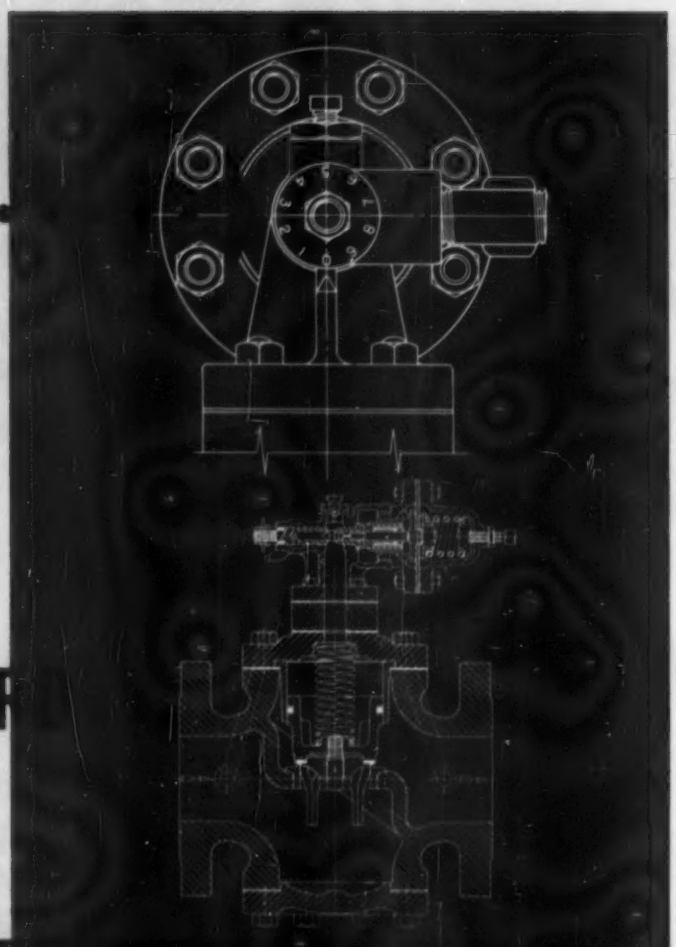
FOR EXCEPTIONAL CONTROL

a pilot-operated valve with adjustable throttling range

the NEW Improved

CASH STANDARD

TYPE 10 VALVE



- SELF-CONTAINED
- SINGLE SEAT— tight closure
- LARGE CAPACITY

SERVES AS PRESSURE REDUCING-REGULATING OR BACK PRESSURE VALVE

- Improved Y-type strainer in pilot control line protects pilot.
- Simple dial-type range selector permits selection of throttling range required for the most stable and sensitive control.
- Switching control piping easily converts valve from pressure reducing to back pressure operation.
- Diaphragm assembly easily changed to convert to different pressure range.
- Packless design results in low friction and high sensitivity.
- Recommended for: water systems, altitude control, as an unloading valve on extrusion presses, back pressure control, oil refineries.
- For use with water, gas, air, light oils, refrigerants (ammonia, freon).
- Materials: iron, bronze or steel body; bronze or stainless steel trim; monel trim on pilot valve. Composition or metal seat.
- Sizes: 2" to 3" with screwed ends.
  2" to 12" with flanged ends.

WRITE TODAY FOR COMPLETE INFORMATION AND LITERATURE

CASH C S **STANDARD**

A. W. CASH COMPANY • P.O. BOX 551, DECATUR, ILL.

PRESSURE, HYDRAULIC, TEMPERATURE, PROCESS AND COMBUSTION CONTROLS

Syracuse U. burns coal the modern way for dependable steam supply

Over the past decade, there has been a growing demand on the steam plant at Syracuse University. Not only has the university itself expanded rapidly, but six hospitals on or adjacent to the campus depend on university facilities for steam. When the original steam plant proved inadequate (total output 190,000 lbs. per hr.), the university built a completely up-to-date unit to replace it.

The internal operation of this new plant is as modern as its panel and glass exterior. An automatic handling system delivers the coal from hopper to bunker to pulverizer to boiler. A pneumatic-type integral combustion control system operates the boilers automatically. A pneumatic disposal system removes fly ash and cinder ash automatically. Today Syracuse University is assured an adequate steam supply—capacity 300,000 lbs. per hr.—and a clean, economical operation in the process.

Investigate Your Fuel Costs

If you're planning to modernize your plant or build a new one—or if you are just interested in cutting fuel costs—find out how coal, burned the modern way, compares to other fuels. Why not talk to a consulting engineer or your nearest coal distributor? Their advice may save you thousands of dollars each year.

facts you should know about coal

Up-to-date coal burning equipment can give you 10% to 40% more steam per dollar.

Automatic coal and ash handling systems can result in a virtually labor-free plant.

Coal is the safest fuel to store and use. No dust or smoke problems when coal is burned with modern equipment.

In most industrial areas, bituminous coal is the lowest-cost fuel available.

Between America's vast coal reserves and mechanized coal production methods, you can count on coal being plentiful and its price remaining stable.

For further information or additional case histories showing how other plants have saved money burning coal, write to the address below.

NATIONAL COAL ASSOCIATION
Southern Building, Washington 5, D.C.

NEW Advanced Design...

NEW HIGH SUSTAINED ACCURACY . . .
even under extreme operating and ambient conditions

NEW CONVENIENT ZERO ADJUSTMENT . . .
external—no need to remove weather-proof cover

FACTORIES IN THE UNITED STATES, CANADA AND ENGLAND

d/p Cell Flow Transmitter...

NEW POSITIVE OVERRANGE PROTECTION . . . up to full 1500 lbs. cell rating

6 Major Achievements!

NEW FULLY ADJUSTABLE RANGE . . . from 0-50" to 0-250" H_2O differential

NEW AUTOMATIC INTERNAL DAMPING . . . fast, stable measurement

NEW SIMPLICITY . . . lowest cost installation

Pioneered by Foxboro 7 years ago, the d/p Cell* Transmitter established a new standard of performance in flow measurement and control. Over 40,000 are maintaining that standard in every branch of industry today. Technical advances, based on this unequalled experience, now have added even further reliability, economy and convenience. Call your Foxboro representative for a demonstration. Write for new Bulletin 13-11.

*Reg. U. S. Pat. Off.

FOXBORO
REG U S PAT OFF

first in flow measurement

THE FOXBORO COMPANY, 687 NEPONSET AVE., FOXBORO, MASS., U.S.A.

Boilers in Chicago's are equipped with

PRUDENTIAL BUILDING will have Chicago's tallest rooftop, providing observation-floor visitors with view of four states. TV antenna will rise to a point 925 feet above street level. *Naess & Murphy, Architects and Engineers. Geo. A. Fuller, Contractors.*

The majestic new 41-story Prudential Building, mid-America home office of the Prudential Insurance Company of America, will provide Chicago with more than one-million square feet of net rentable space together with the very latest in office facilities.

To handle the heating load for this modern 600-foot structure, three Erie City VC Steam Generators, producing a combined total of more than 100,000 pounds of steam per hour, were installed.

Built by Erie City Iron Works of Erie, Pa., these spreader stoker-fired boilers are tubed with Republic ELECTRUNITE® Boiler Tubes, a popular choice among consulting engineers today for several important reasons.

They know, for example, that because ELECTRUNITE Boiler Tubes have a uniform wall thickness, there is uniform heat transfer all around the tube; that ELECTRUNITE's ductility makes installation easy—often less expensive. Smooth bends are made without wrinkling or buckling. And the tubes roll in smoothly to assure tight, weeper-free joints.

To obtain uniform ductility at every point along the length, tubes are fully normalized under controlled atmosphere. This results in clean, scale-free surfaces—gives ELECTRUNITE Tubes their characteristic high-quality finish. Each length is hydrostatically or electrically tested in accordance with the applicable specification. The result is a maximum performance tube that meets all code and boiler insurance requirements.

From an economic viewpoint, it pays to specify ELECTRUNITE Boiler, Condenser and Heat Exchanger Tubes. Send coupon for brand new booklet that gives complete facts and specifications.

REPUBLIC STEEL CORPORATION
3144 East 45th Street
Cleveland 27, Ohio

Please send me the item or items checked below:

- ☐ New ELECTRUNITE Booklet B-5
- ☐ Chart on Care and Maintenance of Boiler Tubing
- ☐ Information on availability of film "Intestinal Fortitude"

Name_____ Title_____

Company_____

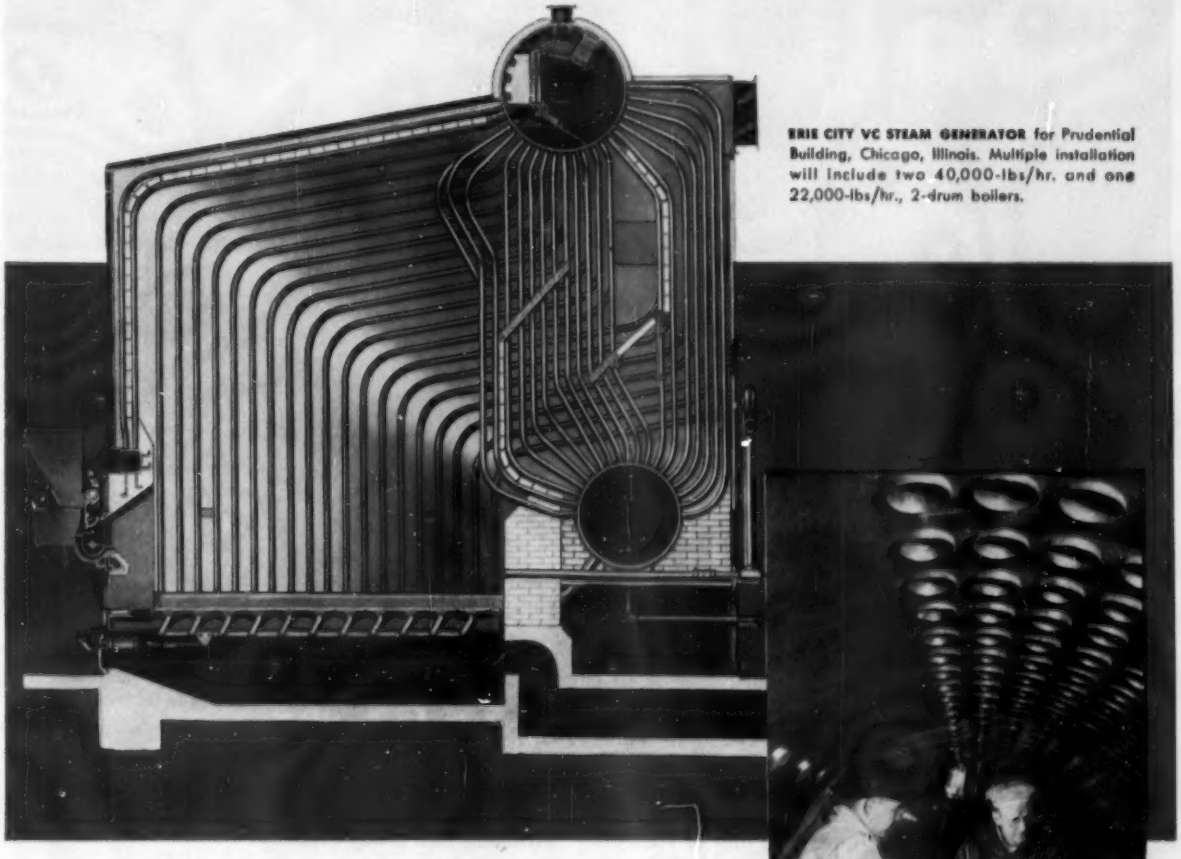
Address_____

City_____ Zone_____ State_____

REPUBLIC STEEL

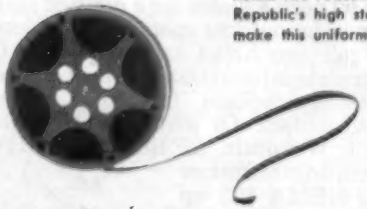
World's Widest Range of Standard Steels and Steel Products

newest office building ELECTRUNITE Boiler Tubes



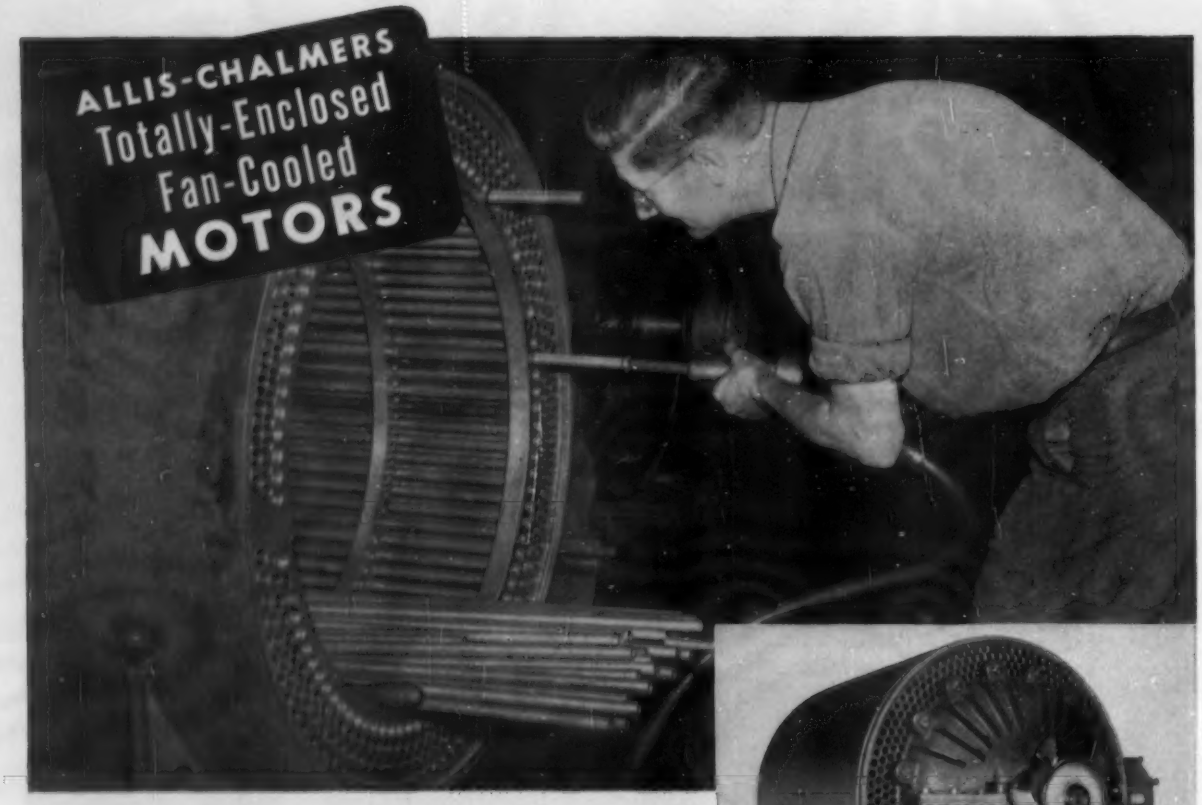
ERIE CITY VC STEAM GENERATOR for Prudential Building, Chicago, Illinois. Multiple installation will include two 40,000-lbs/hr. and one 22,000-lbs/hr., 2-drum boilers.

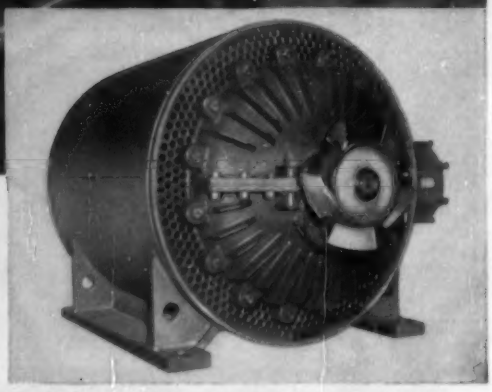
BOILER ERECTORS LIKE THE WAY ELECTRUNITE BOILER TUBES SLIDE EASILY into boiler drums and expand into the tube holes. The reason: uniform diameter, uniform ductility. Republic's high standards of ELECTRUNITE quality control make this uniformity possible.



SEND FOR FILM "INTESTINAL FORTITUDE"—16 mm., sound, black and white, 17 minutes. The story of ELECTRUNITE Pressure Tubes. A short introduction reviews progress of iron ore from mines to blast furnace —then pictures necessary steps in the manufacture of flat-rolled coils of steel from which tubing is made — and finally, how ELECTRUNITE Tubing is made. To arrange for showing, mail coupon.

HOW AVAILABLE! CHART ON CARE AND MAINTENANCE OF BOILER TUBING. Here's a handy guide for protecting your boiler installation from corrosion, erosion, physical wear and tear. If your boiler is going to be shut down for any period, you should have this information. Convenient chart form for hanging in your boiler room. Send coupon.





3600-rpm explosion-proof motor with fan housing removed to show unidirectional fan.

These heat exchanger tubes

Protect this motor from dirt and corrosion

COOLING AIR is carried through the heat exchanger tubes with sufficient velocity to expel practically all kinds of dirt. If oily or sticky dirt should cling, tubes can be ramrodded clean on the spot in a few minutes because tubes are straight and tube ends are exposed. Also, the tubes are distributed uniformly around the perimeter of the stator yoke and along its full length — cooling all parts of the motor evenly.

Choice of Corrosion-resistant Materials

You can lick corrosion with this motor, too. Tubes are available in a variety of materials to meet practically any corrosive atmospheric condition. Allis-Chalmers tube-type motors have long and successful experience in such difficult applications as caustic plants, refineries and petrochemical plants, power plants with fly ash problems and many others.

Get Complete Information

Next time you need a motor for a dirty or corrosive location or for outdoor operation in all kinds of weather, call your Allis-Chalmers District Office. Get complete information on Allis-Chalmers tube-type totally-enclosed, fan-cooled and explosion-proof motors. Or write Allis-Chalmers, Milwaukee 1, Wisconsin, for Bulletin 51B7149. Available in ratings on frames larger than NEMA 505 up to 3000 hp.

A-4589

ALLIS-CHALMERS

POWERFUL GUY!

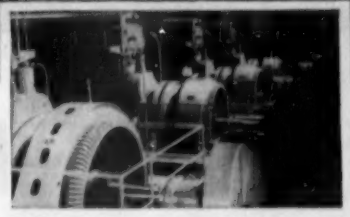
His four Nordberg Diesels, lubricated by Cities Service DC-940 Oil, supply six Oklahoma Counties with REA power. Have one of lowest cost-per-KWH records of entire REA.

His name's H. P. Wingo, and he's Chief Engineer of the REA plant operated by Western Farmers Electric Cooperative.

For the past four years, since his plant began operation in Woodward, Oklahoma, he's been responsible for a consistently high power efficiency rating, measured in cost per kilowatt hour...as high as fifth among all 42 REA plants! To maintain this record, he's had important help... help from four 1100 KW Nordberg dual-fuel engines...and help from Cities Service DC-940 Oil.

"Our engine compressions are the same today as they were after the first three months' operation," says Wingo. "In addition, using Cities Service DC-940, rings have remained absolutely free, liners have worn less than .0015, and we average 14,000 horsepower hours per gallon of oil. Filter elements last up to 1,500 hours."

Wingo has added his words of praise to those of scores of other users of Cities Service Lubricants. Summed up, these reports clearly demonstrate that superior performance is not the exception, but the rule, with Cities Service products. Your Cities Service Lubrication Engineer can readily explain why. Talk it over with him. Or write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

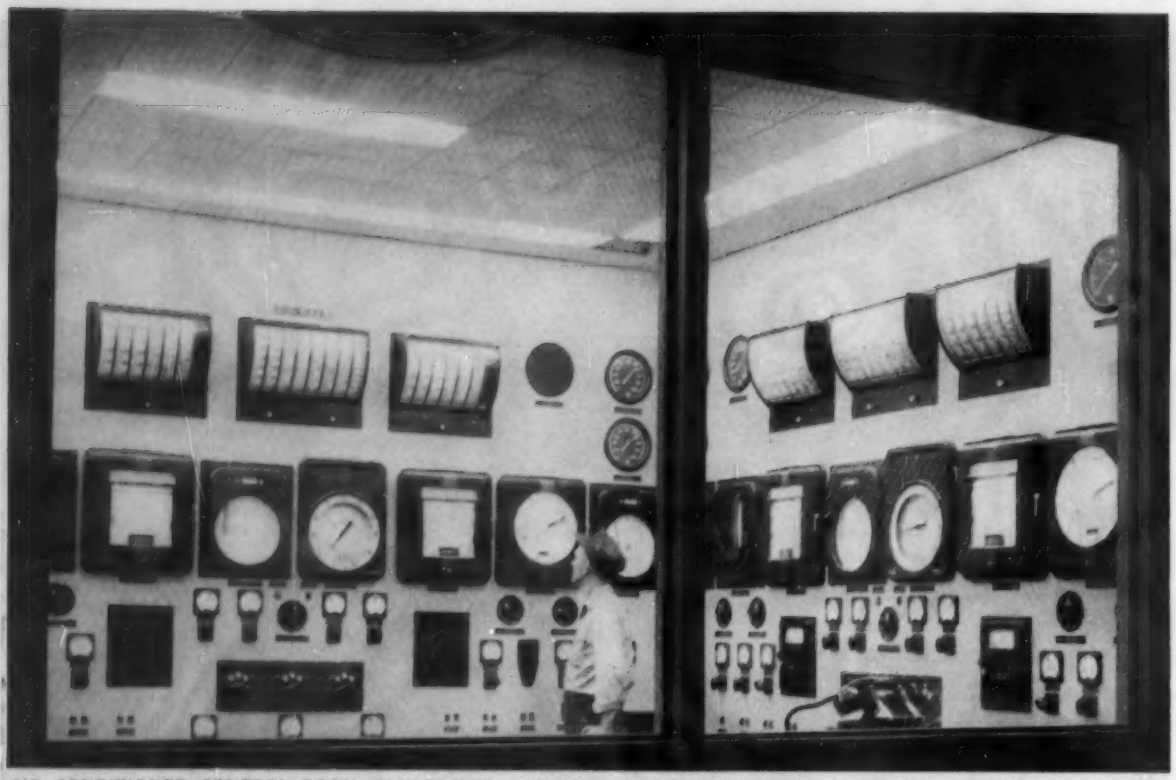


4 NORDBERGS, 4 YEARS OLD . . . yet engine compression remains the same as after first three months of operation at Western Electric REA Plant, Woodward, Okla. Rings "absolutely free," liners worn less than .0015, oil consumption at 14,000 H.P. hrs. per gallon using Cities Service DC-940 Oil.

CLOSE CHECK is kept on entire operation. Meanwhile, Cities Service Lubrication checks wear in Nordberg engines, helps engineer Wingo maintain record of low cost electricity. Supplying economical power to six Oklahoma Counties, plant's power efficiency rating has been as high as 5th in entire REA.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS



AIR CONDITIONED CONTROL ROOM ILLUSTRATES COMPLETE BOILER PLANT INSTRUMENTATION SUPPLIED BY HAYS.

MULTIPLE FUEL COMBUSTION CONTROL OF CYCLONE FURNACES

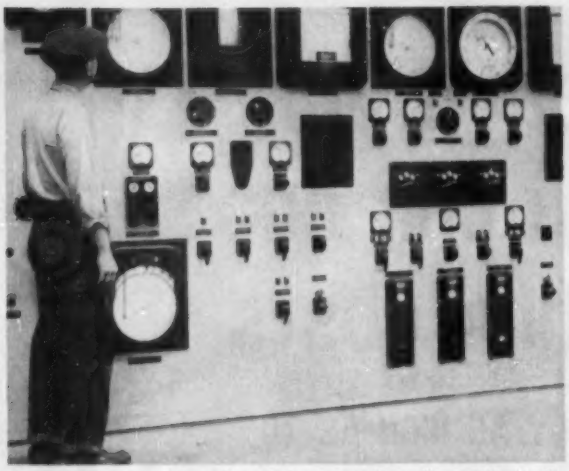
At Michigan City Station of Northern Indiana Public Service Co.*

Flexible, efficient, safe firing of *both* coal and gas in cyclone furnaces is being achieved at the Michigan City, Indiana generating station of NIPSCO* by means of an electric combustion control system designed and built by engineers of The Hays Corporation working closely with company officials and the consulting engineers, Sargent & Lundy.

The system permits any desired allocation of load among the three boilers, between the two cyclone furnaces of a given boiler and between the two fuels being burned simultaneously in a given cyclone. Thus, any conceivable load-need or fuel supply situation can be accommodated.

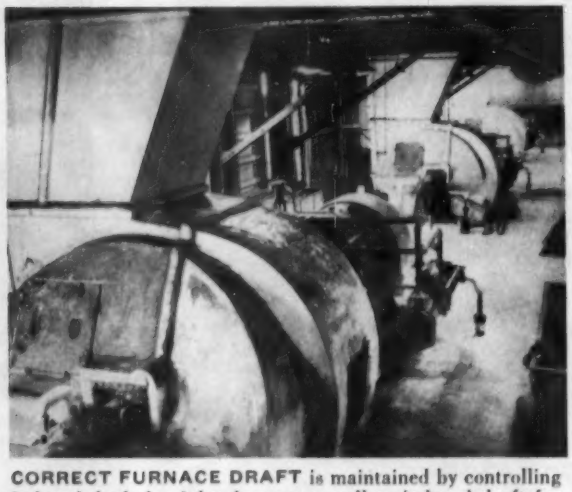
In addition, complete safety for the multi-million dollar installation is "built in" since each boiler is equipped with a system of mechanically and electrically interlocked selector switches arranged to require a definite sequence of operation in transferring from manual to automatic control and vice versa. For example, interlocks require that (1) the ID fan must be running (2) the ID fan damper must be partially open and (3) at least one of the FD fan duct dampers must be opened before the FD fan can be started.

This installation illustrates the care and ingenuity exercised by Hays engineers in solving the combustion control problems of boiler plant operators throughout the world—regardless of boiler size, fuels being burned, etc. Write for a free, fully illustrated, 8-page story on this central station —available from The Hays Corp., Michigan City, Indiana.

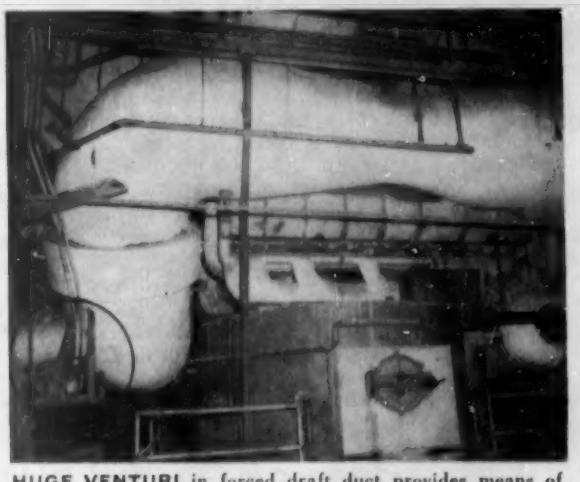


SPACE SAVING is achieved by mounting all position indicators, manual control stations, fuel-air ratio adjustments, and mechanical interlocks for one boiler inside control room

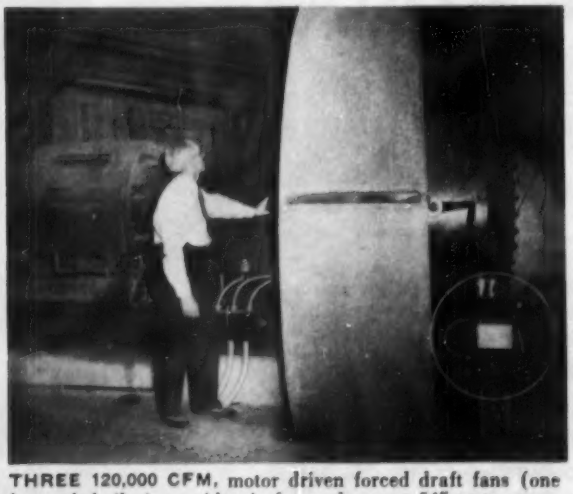
near related instruments for convenience of operator (*at left*); controllers themselves are grouped on outside wall of control room for ease of inspection and maintenance (*at right*).



CORRECT FURNACE DRAFT is maintained by controlling induced draft fan inlet damper as well as induced draft fan speed. Latter is accomplished by means of hydraulic coupling equipped with reversing oil pump.



HUGE VENTURI in forced draft duct provides means of accurately measuring air to individual cyclone. The Hays power unit *(indicated within circle)* operates a damper in this forced draft duct.



THREE 120,000 CFM. motor driven forced draft fans (one for each boiler) provide air for cyclones at 54" water pressure. Hays power unit (*circle*) adjusts forced draft fan inlet damper in response to forced draft duct pressure controller.

Automatic Combustion Control
Boiler Panels • Hays-Penn Flowmeters
Venturi Meters and Veritrol
Gas Analyzers • Draft Gages
Combustion Test Sets • CO_2 Recorders
Electronic Oxygen Recorders

THE hays CORPORATION

MICHIGAN CITY 3, INDIANA

How exhaust heat from a G-E Gas Turbine can cut your plant operating costs

NEW CYCLE CAN RESULT IN EFFICIENCY AS HIGH AS 70%

With more than 675,000 hours of successful commercial operation to their credit, General Electric gas turbines now offer power engineers this *new* formula for lowering processing costs:

Use the gas turbine to drive a generator of up to 16,000 kw or mechanical equipment up to 21,500 hp; pass the exhaust heat through a heat-recovery boiler to supply plant process steam up to 95,000 lbs. per hour. (If more process steam is required, use supplementary fuel firing to obtain up to 270,000 lbs. per hour.)

The resulting over-all efficiency may be as high as 70%!

Operating costs are low because gas turbines offer not only fuel savings resulting from high-cycle efficiency, but also economies in water, lubricating oil, maintenance, and manpower requirements. In addition, modified low-cost residual fuel oil can be burned in G-E gas turbines to provide even greater economy.

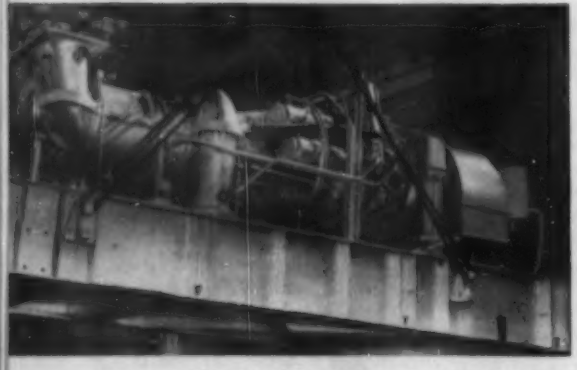
Initial costs are low too. Only small buildings and simple foundations are needed to install a G-E gas turbine; a new self-contained base houses most related auxiliary equipment.

Your company may well profit from using a G-E gas turbine, and General Electric will be happy to work out an economic study with you.

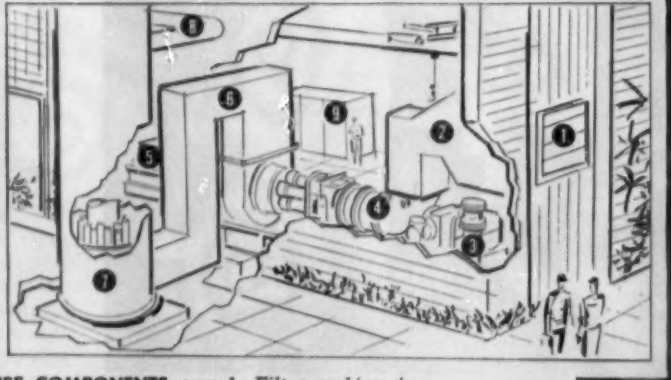
For more information contact your nearest G-E Apparatus Sales Office or write for Bulletin GEA-5516B. General Electric Company, Section 261-16, Schenectady 5, New York.

Progress Is Our Most Important Product

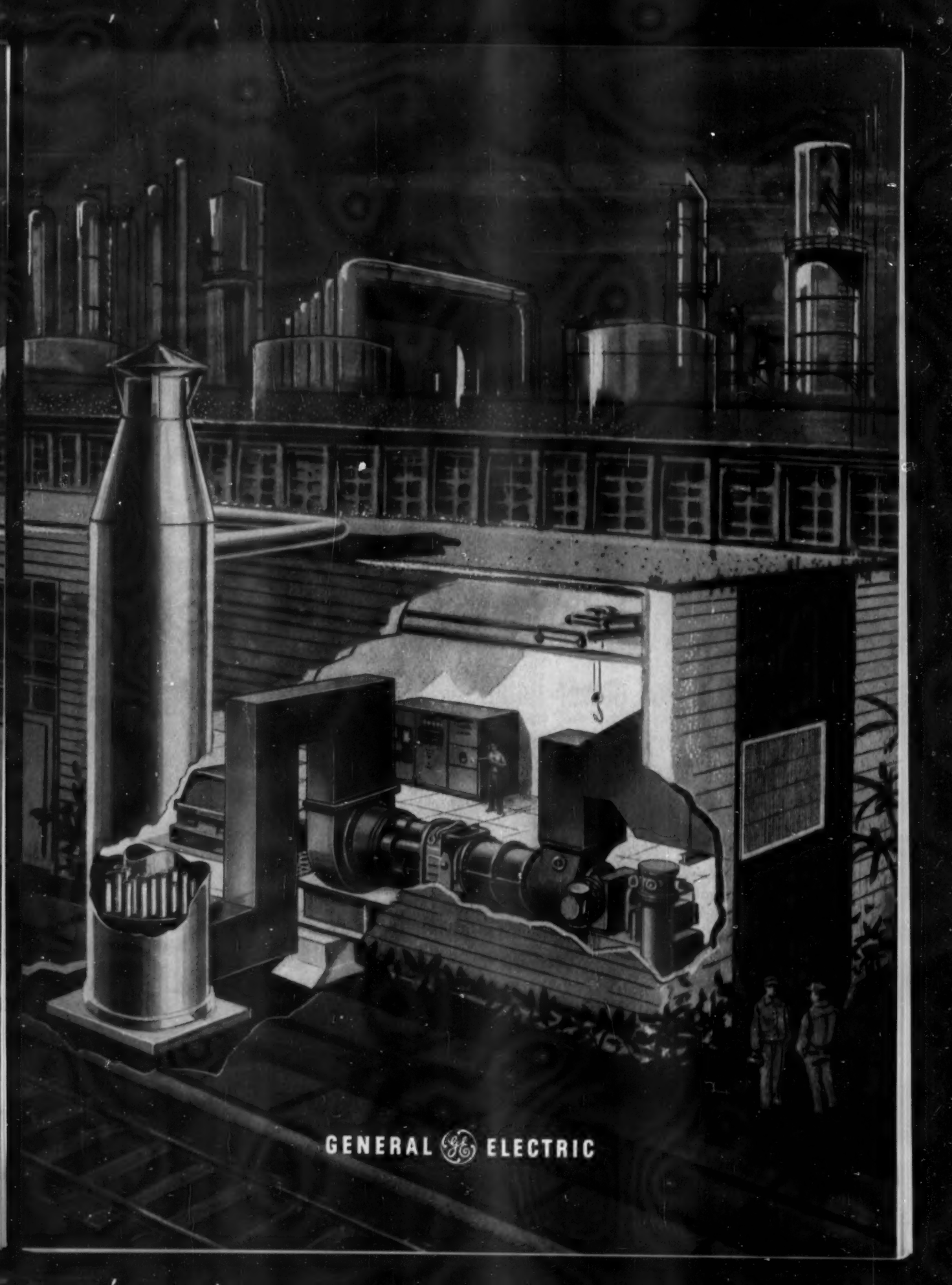
GENERAL ELECTRIC

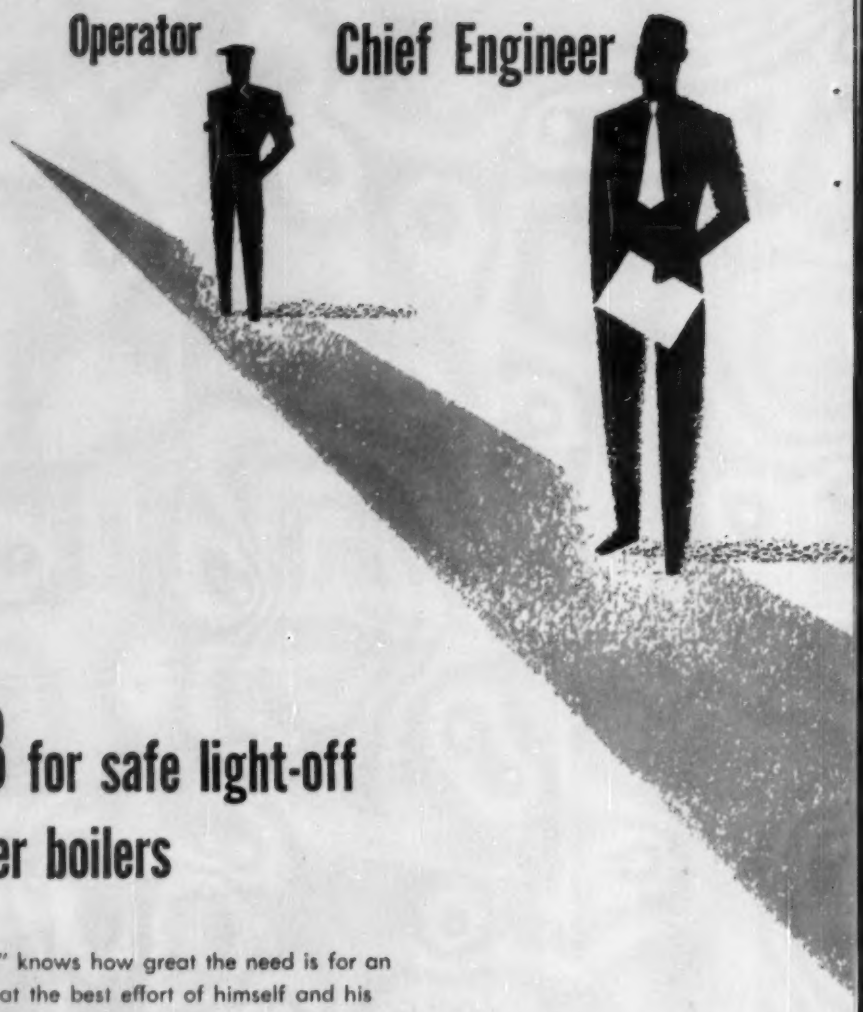


TREMENDOUS SAVINGS in installed cost have been made possible by this new gas turbine base mounting, recently developed by G-E engineers. Serving as a rigid foundation, it also houses most of the auxiliary equipment.



CHIEF COMPONENTS are: 1. Filter and/or air washer, 2. inlet duct, 3. starting unit device, 4. gas turbine, 5. gas compressor or driven equipment, 6. exhaust duct, 7. exhaust heat recovery boiler, 8. steam to process, 9. control unit.


GENERAL ELECTRIC



You need ALL 3 for safe light-off and firing of power boilers

Any able and experienced "Chief" knows how great the need is for an assistant like Fireye. He knows that the best effort of himself and his operating men isn't enough to eliminate the hazards of incorrect light-off and flame failure – hazards which insurance surveys show cause 85% of furnace explosions.

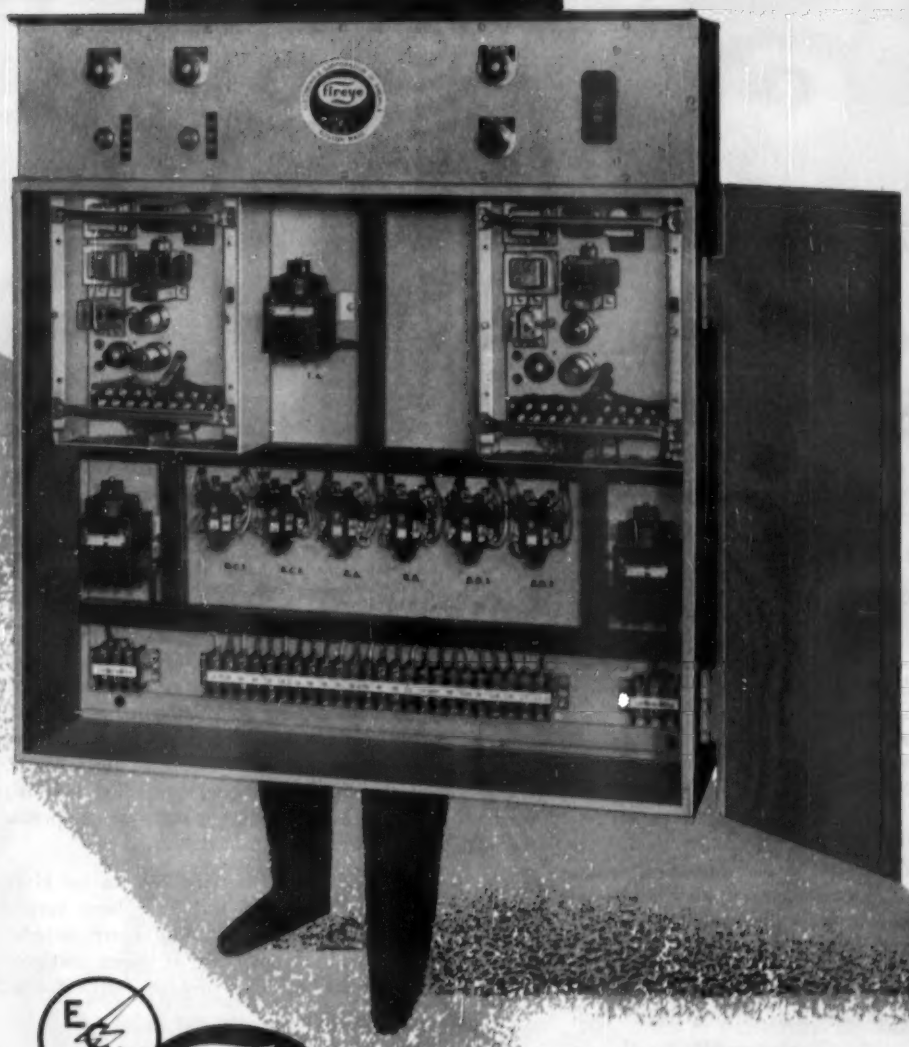
Fireye gives you protection assurance that's obtainable only with a factory-integrated system of timers, interlocks, and shutoff valves. It controls every stage of burner operation. And, if a flame fails, Fireye shuts off fuel in 2 to 4 seconds . . . will not allow re-ignition before the combustion chamber is completely cleared of explosive gases.

The system may be installed on any multiple burner boiler. Installation by qualified Fireye engineers is part of our national service, when desired.

Get important new manual . . . "How to Burn Fuel Safely", an authoritative easy-to-understand manual which tells how to spot operating hazards and safeguard against them. Use the coupon to get it. Or, ask your local Fireye representative for a copy.

now fireye

the "3rd man" in your boiler room



New INTERLOCK System automatically . . .

PREVENTS hurrying or bypassing steps essential to safe boiler operation.

PREVENTS light-off until combustion chamber and passages are purged free of combustibles.

PREVENTS supplying main fuel until pilot is proved at a point satisfactory for light-off of main fuel.

SHUTS OFF FUEL if main flame is not stable within safe trial-for-ignition period.

SHUTS OFF FUEL and sounds alarm if flame goes out during firing period.

ECA fireye

First and Foremost in Controls for Safe Fuel Burning

Other ECA Divisions: Photoswitch Division • Fireye Division • Marine Division • Business Machines Division • Photoconductor-Transistor Division • Military Division

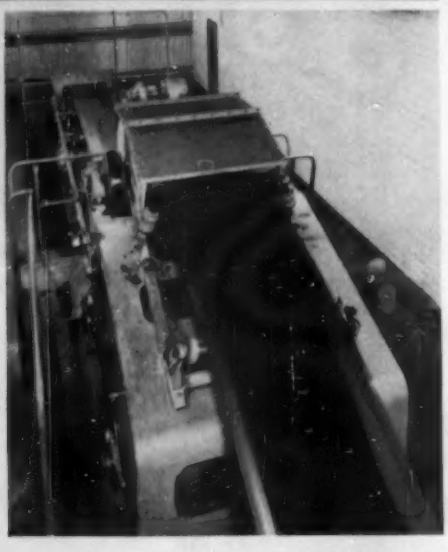
COMBUSTION CONTROL DIVISION
ELECTRONICS CORPORATION OF AMERICA
Dept. C9-7, 718 Beacon St., Boston 15, Mass.

Please send me your new manual — "How to Burn Fuel Safely".

NAME AND TITLE _____

COMPANY _____

STREET _____ CITY _____



Self-propelled, hand reversing belt tripper in the powerhouse feeds coal to bunkers.

Bedding Boom Conveyor Prevents Segregation in New Coal Handling System

HARTFORD ELECTRIC LIGHT COMPANY
MIDDLETOWN, CONN. STATION

How to stockpile coal 40-ft. high without separating the fines and causing compaction problems — this was a major consideration in designing a coal handling system for this new power plant. A boom conveyor which pivots both vertically and horizontally proved to be the answer. It can be adjusted to discharge directly on the top of the pile, regardless of height. This prevents coal segregation, allows good compaction and minimizes the danger of spontaneous combustion.

The boom conveyor is part of a complete conveying system designed and built by S-A. This system takes coal from track hoppers, feeds it by means of a plate feeder onto a slope conveyor belt and delivers it to a crushing house. From there, coal may go to the stocking-out system or through the crusher and onto a 642-ft. belt running to the top of the powerhouse. Coal is recovered from the stockpile through a special reclaiming hopper. This hopper loads a reversible flat belt conveyor which may feed either the crusher or deliver the coal directly to the powerhouse conveyor. Once in the powerhouse, the coal is transferred to a self-propelled belt tripper which loads the bunkers. The entire system operates at 300-tons per hour using 36-in. belts.

This is the second S-A Conveying System for Hartford Electric. Repeat orders like this have been earned by S-A's ability to design and manufacture dependable conveying systems that move coal at lowest cost per ton. If you have a coal handling problem, write for a free survey. No obligation.

STEPHENS-ADAMSON MFG. CO.

3 Ridgeway Avenue, Aurora, Illinois • Los Angeles, Calif. • Belleville, Ontario

Engineering Division
Specialists in the design and manufacture of all types of bulk materials conveying systems.

Standard Products Division
A complete line of conveyor accessories including centrifugal loaders — car pullers — bin level controls — etc.

Sealmaster Division
A complete line of industrial bal bearing units available in both standard and special housings

Improve Heat Transfer ...Reduce Maintenance

by Eliminating Corrosion

Even when an efficient deaerator removes free carbon dioxide from your system, additional CO_2 produced by decomposition of bicarbonates and carbonates remains to cause return line corrosion. Residual oxygen causes pitting. Protecting against both CO_2 and O_2 considerably reduces the cost of replacing and maintaining steam and return lines. Keeping the system free of corrosion products assures high heat transfer efficiency.

One series of Allis-Chalmers corrosion inhibitors solves this problem by neutralization. These materials are blends of the most effective amines selected according to the volatility characteristics required by each steam condensate system. Protection is provided against both CO_2 and O_2 at the points where it is needed.

Although recommendations for your specific needs can be made only after thorough analysis, you can get more information about use of this series by obtaining a copy of Allis-Chalmers Water Conditioning Informational Bulletin 50. Get a copy from your nearby A-C office or write Allis-Chalmers, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

Water Conditioning—Chemicals, Equipment, Service—for more than 25 years

A-4406

Delivery...ON TIME...

A delay on this particular job meant valuable time lost . . . dollars wasted . . . Ric-Wil, not only prides itself in offering the finest in prefabricated insulated piping, but takes pride in ON TIME DELIVERY . . . and speaking of delivery . . . the best way to meet piping construction schedules is to contact your Ric-Wil representative early in the planning stage. He will be glad to help on scheduling delivery . . . and "lend a hand" on technical information as well.

New Ric-Wil catalog is available . . . write for your copy . . . now.

Quality Piping Systems . . .
. . . of Exceptionally High Thermal Efficiency

RIC-WIL INCORPORATED

PREFABRICATED **INSULATED PIPING SYSTEMS**

BARBERTON, OHIO

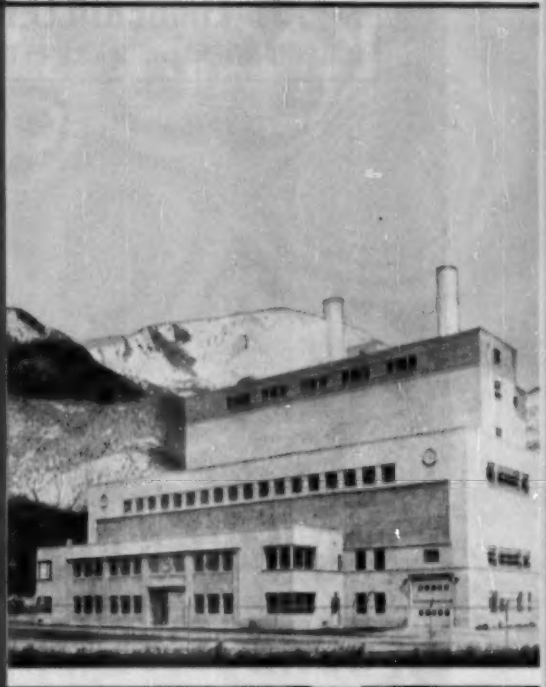
Birdsall Power Station benefits from past experience... turbines get NONPAREIL *Turbine Oil*

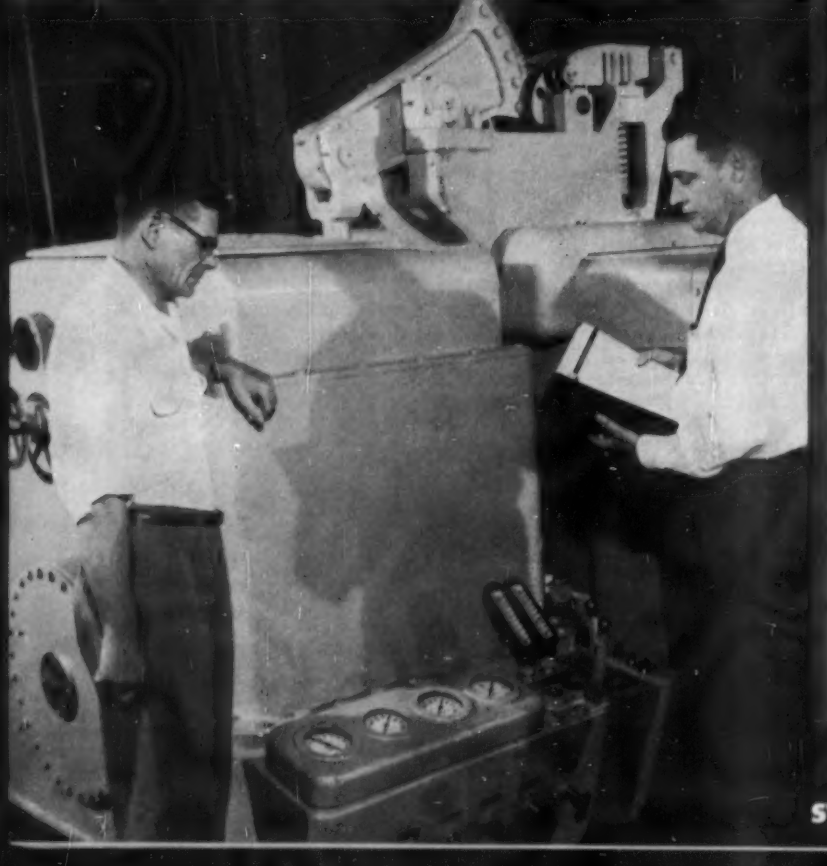
Colorado Springs Utility Department had 12 years' experience with NONPAREIL Turbine Oil in other turbines in the system before the George Birdsall Power Station began operations in 1952. When it came to selecting a turbine oil for two 16,500 kw. GE turbines in the Birdsall Plant, NONPAREIL Turbine Oil was decided upon. The trouble-free service already obtained with NONPAREIL helped make the decision to use it in the Birdsall plant an easy one.

There was another factor besides the 12 year trouble-free record that helped the management decide on NONPAREIL. It was the NONPAREIL guarantee which assured them NONPAREIL would last the life of the turbines. This guarantee assures the user that the acidity of the oil will never exceed 0.15 mg. KOH/g. In most cases the acidity level is maintained at a much lower figure, usually on the order of 0.05 mg. KOH/g. Regular inspection by Standard Oil lubrication specialists and analysis of the oil in Standard Oil laboratories serve as a double check on the oil's performance. This adds up to certain, superior lubrication for turbines.

Find out more about NONPAREIL Turbine Oil. In the Midwest, call your nearby lubrication specialist. Or contact, Standard Oil Company, 910 South Michigan Avenue, Chicago 80, Illinois.

A truly show-place station is the Birdsall Power Station of Colorado Springs. Two GE 16,500 kw. turbines use NONPAREIL Turbine Oil.





C. J. Blasing, Mechanical Superintendent (left), and Standard Oil lubrication specialist E. C. "Con" Jefferies, check lubrication data on GE turbine at Birdsall plant. Providing technical service on lubrication jobs such as this is something for which Con Jefferies is well suited. Con has a number of years experience working with industry on lubrication problems. In addition he is a graduate of the University of Colorado with an ME degree and has completed the Standard Oil Sales Engineering School. Customers find this experience and background pay off for them.

STANDARD

STANDARD OIL COMPANY (Indiana)

IF YOU HAVE A CONVEYOR JOB HANDLING ABRASIVE OR CORROSIVE MATERIAL... *HERE'S YOUR IDLER!*

The Joy Limberoller idler installation shown above is in a magnesium foundry, supporting a 30″ belt which carries abrasive material up a 35° slope. *To date, these idlers have been on the job 10 times longer than conventional idlers previously lasted—and they're still going strong!*

ONLY 2 BEARINGS, UP OUT OF THE DIRT ...The Joy Limberoller idler consists of neoprene discs molded on neoprene-covered flexible steel cable. It is suspended from two bearings, one on each end, *out of the dirt zone.* This distinctive design, field-proved by thousands of idlers already in service, averts fouled idler rolls—protects the belt from damage—reduces your maintenance to a fraction.

OTHER ADVANTAGES, TOO . . . Joy idlers are self-training—they conform to the load with a cushioned grip which supports the loaded belt without slipping and reduces belt wear. They resist corrosion, abrasion, flame and grease—weigh ⅔ less than steel idlers, and handle bulk or packaged materials equally well. They're easily changed *without stopping the belt,* and compactly stored.

Whatever your belt conveyor job may be, let us help you to make it more efficient and economical. Joy Limberoller Idlers are available for belt widths of 18″, 24″, 30″ and 36″—and you'll find them easier, faster and less costly to install, maintain, knock down and move than any other conveyor idler on the market. ● ***Joy Manufacturing Company, Oliver Building, Pittsburgh 22, Pa.*** In Canada: *Joy Manufacturing Company (Canada) Limited, Galt, Ontario.*

WRITE FOR COMPLETE DETAILS

Ask for free *Bulletin LD-103C.* It gives complete information on the unique Limberoller Idler, and we'll be glad to supplement it with engineering assistance on your particular problem.

Consult a Joy Engineer

WBD 19699

JOY

SINCE 1851—OVER 100 YEARS OF ENGINEERING LEADERSHIP

It's Quality Deserves Consideration

FISHER®
LEVEL-TROL®

UPPER and LOWER SIDE CONNECTIONS

TOP and LOWER SIDE CONNECTIONS

UPPER SIDE AND BOTTOM CONNECTIONS

Factory calibrating or zeroing adjustment produces a correct 3 to 15 pound signal output for full float range operation, as particularly required in liquid level indication. Output signal of controller is linear as related to level height change.

Simple level adjustment indicating dial.

Pneumatic proportional band and specific gravity adjustment combined in one member.

Small compact relay unit, minimum working parts.

★ All welds are in accordance with ASME code for unfired pressure vessels.

Universally Accepted for

- LIQUID LEVEL CONTROL
- LIQUID LEVEL INDICATION
- INTER FACE CONTROL

Engineered for peak performance the Fisher Series 2500 Level-Trol is designed to give rugged, trouble-free service. It is high in sensitivity and accuracy . . . it is versatile in handling all kinds of liquids, with minimum service attention.

Fisher Bulletin F-3 gives full details . . . write for your copy today!

FISHER GOVERNOR COMPANY • Marshalltown, Iowa

WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

FISHER Since 1880

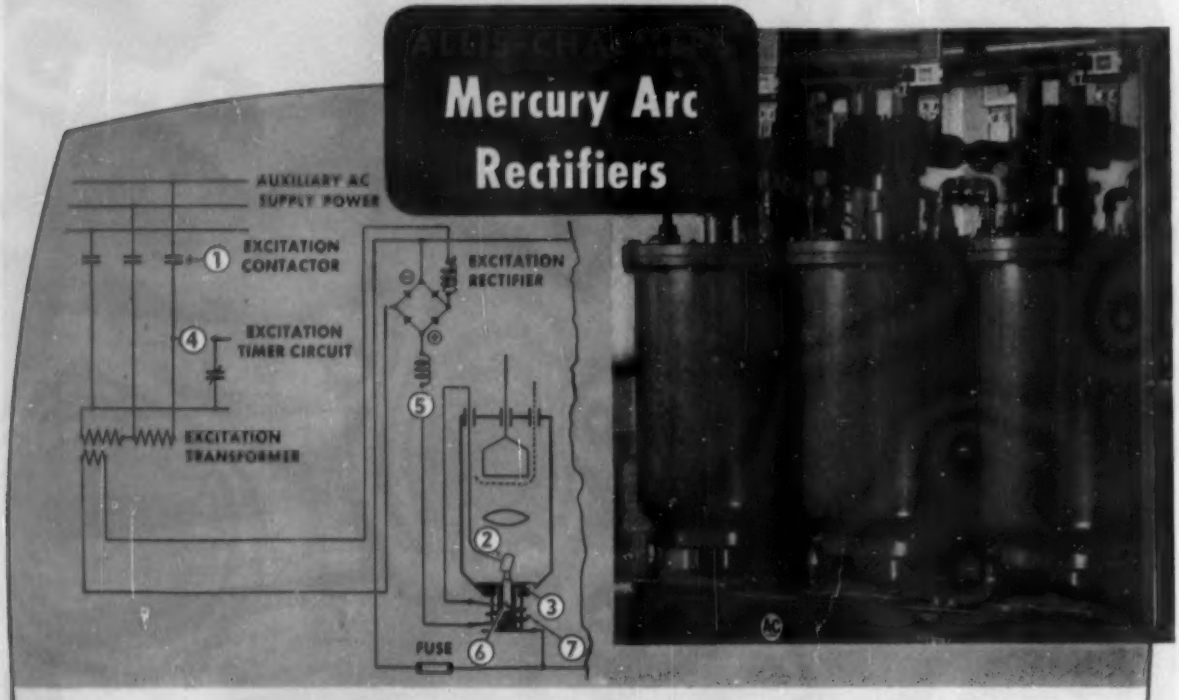
For Reliable Rectifier Operation Get

Continuous Excitation

Allis-Chalmers excitron rectifiers eliminate the need for a pulse-type firing system timed for operation every cycle. Maintenance is easy because of the simplicity of design.

A small dc excitation arc is automatically ignited only once, when the unit is started, and then maintained on the mercury cathode of each rectifier tube. It offers advantages similar to a pilot light. Since it is far easier to maintain an arc than to start it, this feature makes the excitron far less likely to lose excitation during power supply disturbances than other types of rectifiers.

Get all the facts about excitron rectifiers before your next installation. Call the A-C office nearest you or write Allis-Chalmers, Milwaukee 1, Wisconsin.



Supply of DC Provides Key to Continuous Excitation

Direct current supplied from excitation rectifiers is the key to continuous excitation. When the excitation system is energized by means of a contactor (1), positive dc potential appears on the excitation anode (2) of each tube, negative at the cathode (3). A timer (4), through contacts of the excitation failure relay (5), is energized at the same time.

As soon as voltage is applied, current flows from the anode to the cathode through the ignition plunger (6). This current energizes the ignition coil (7) and causes the plunger to be pulled below the mercury surface. As the plunger travels down, an arc is drawn which transfers from the graphite tip of the plunger to the mercury. This current flow keeps the coil energized, maintaining a continuous arc.

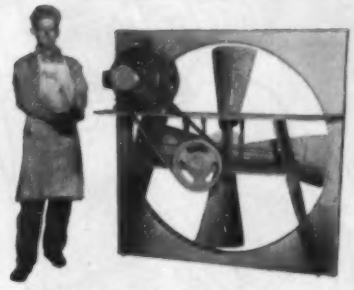
If excitation failure should occur while the rectifier is carrying load, the plunger is released, floating upward in the mercury until it makes contact with the anode, then repeating the process above until the arc is re-established.

Re-establishment of the arc as outlined takes less than a second — it does not interfere with normal operation.

ALLIS-CHALMERS

A-4592

PRACTICAL way to control Boiler Room Ambient Temperatures



Drive side of 48" Belted NV. Gusseted motor and bearing supports are 5/16" plate. Panel is 1/4" plate. Note blades welded to rugged cast steel spider.

"Buffalo"

PACKAGE PROPELLER FANS

These easy-to-install packages are engineered and constructed to the high "Q" Factor* standards of all "Buffalo" Fans. This includes such features as:

Inlet side of 54" Direct Drive Heavy-Duty NV showing spider detail and die-stamped orifice in 1/4" plate panel closely shrouding wheel.

Die-formed flanged panels with smoothly curved orifices closely shrouding wheel — ¼" plate standard construction on sizes 36" and up — larger where heavy motor frames involved.

Die-formed or gusseted motor and ball bearing supports up to ⅜" plate welded integrally to panel.

Heavy-gauge die-stamped blades dynamically balanced and electrically welded to rugged cast steel spiders on size 48" and up.

Motors mounted in air stream for most effective cooling and resultant long life.

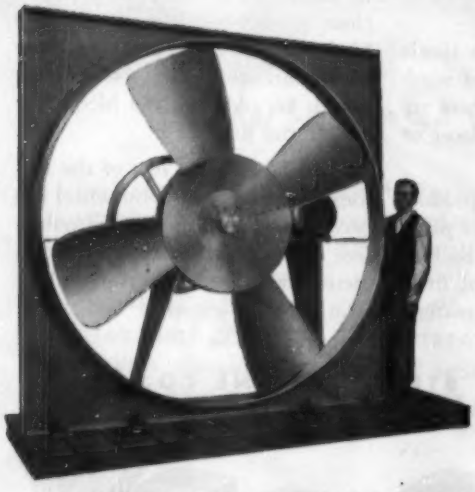
Size range to 120" wheels (250,000 cfm).

Special panel constructions readily available to suit special needs of your particular installation.

As to efficiency, our 96" Fan delivers 131,000 cfm at ⅛" static, on only 15 h.p.

For further facts on this economical, completely practical cooling, write for Bulletins FM-1234 and FM-315. For recommendations, contact your nearest "Buffalo" representative or write to Walter Holt at the address below.

**The "Q" Factor — the built-in Quality which provides trouble-free satisfaction and long life.*



120" Design 53 Belt-Air Fan. Capacity ranges from 107,000 cfm free delivery with 3 h.p. motor to 195,000 cfm at 1/2" s.p. with 40 h.p. motor.

BUFFALO FORGE COMPANY

488 BROADWAY BUFFALO, N.Y.

PUBLISHERS OF "FAN ENGINEERING" HANDBOOK

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

Sales Representatives in all Principal Cities

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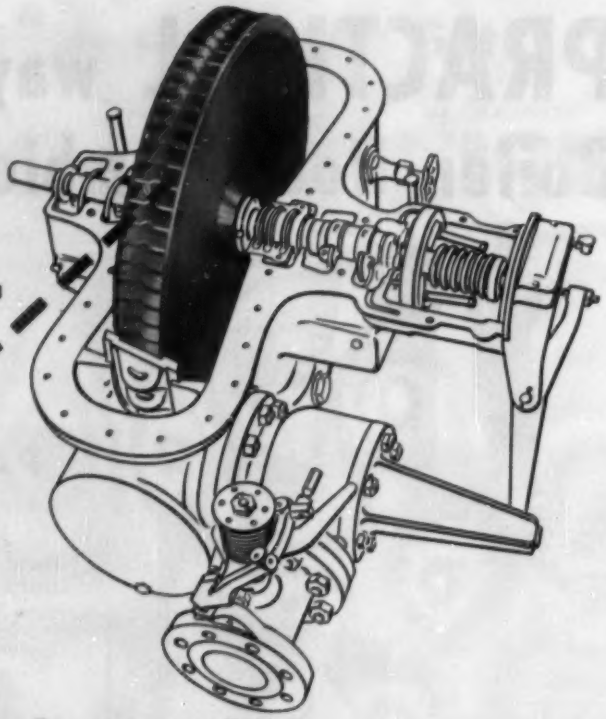
INDUSTRIAL EXHAUSTERS BELTED VENT SETS PROPELLER FANS "E" BLOWERS-EXHAUSTERS

TERRY SOLID WHEEL



..."trade mark" of a trouble-free turbine

This is the rotor of a Terry solid-wheel turbine. There are a number of reasons why it has become a symbol for reliable, trouble-free operation.

First, because the wheel is a single forging, in which a series of semi-circular buckets is milled, there are no separate parts to become loose or work out.

Second, because the power-producing action of the steam takes place on the curved surfaces at the back of the buckets, blade wear is of little consequence. Wear does not materially affect horsepower or efficiency.

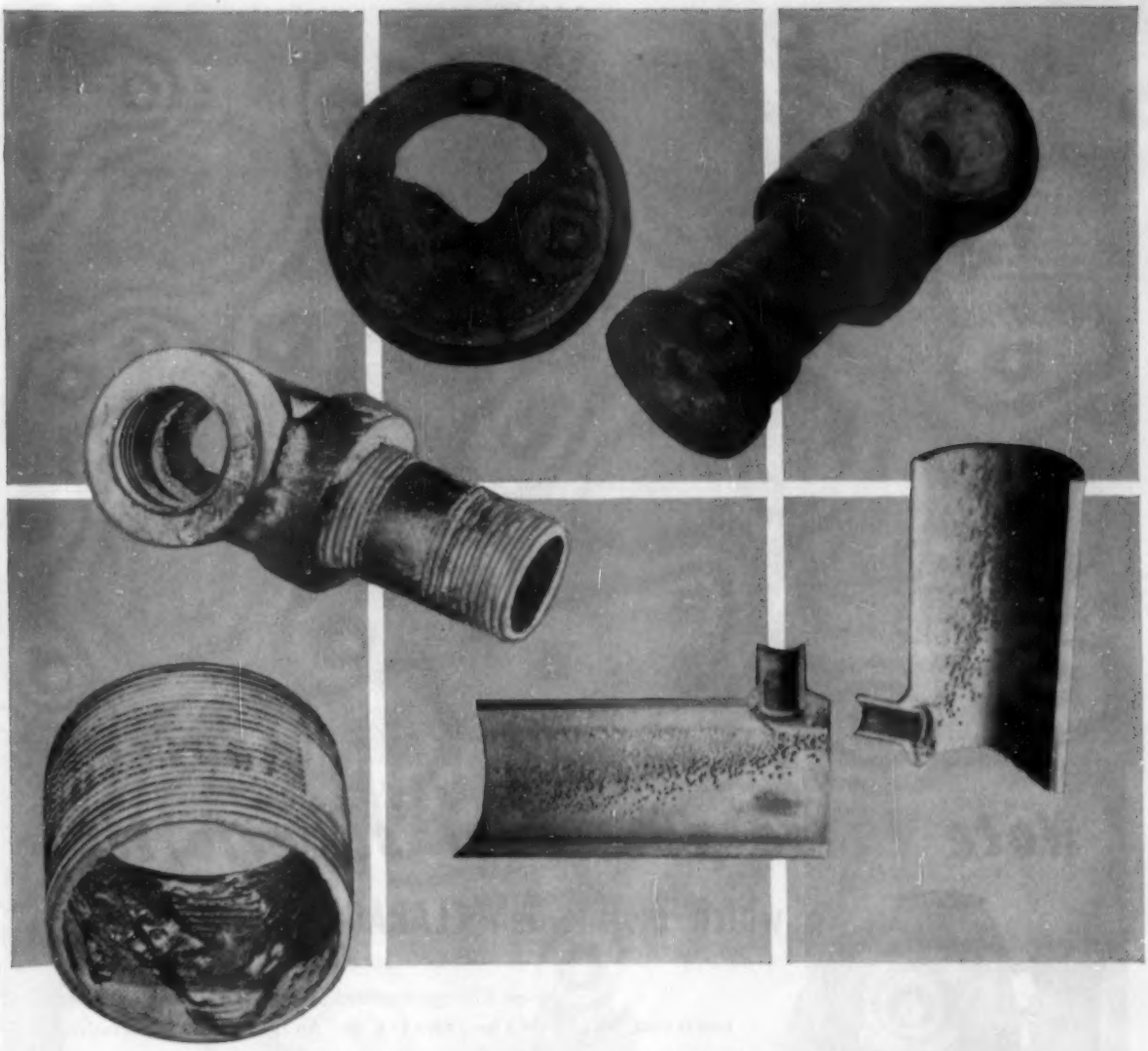
Third, because the steam enters the buckets in a direction at right angles to the shaft, there is no need for close axial blade clearances. The blades cannot foul. There is a one inch clearance on either side of the wheel. In addition, the blades are double rim protected.

These are only a few of the reasons why the Terry solid wheel has become a "Trade Mark" for trouble-free turbine performance. For complete details, send for a copy of bulletin S-116. No cost or obligation.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

TT-1197



WHAT'S YOUR TROUBLE?

Each of these destroyed parts had to be taken out of service because of incomplete or inadequate water treatment. Replacement meant loss of steam production . . . new equipment expense . . . added labor-repair costs.

DEARBORN COMPLETE WATER TREATMENT SERVICE eliminates this by providing trouble-free water—a vital necessity to every user of industrial steam. Dearborn's many years of leadership in the field of water treatment will help keep your power plant operating economically.

CALL ON YOUR DEARBORN SALES ENGINEER for (1) analysis of raw water (2) recommendation of test procedures (3) proper treatment (4) a manually or automatically controlled feeding system.

Dearborn®

combatting corrosion wherever it occurs

Dearborn Chemical Company
Merchandise Mart Plaza, Dept. PO
Chicago 54, Ill.

Please send me

☐ Bulletin 5000 ☐ Bulletin 5013 ☐ Have a Dearborn Sales Engineer call.
☐ Bulletin 5008

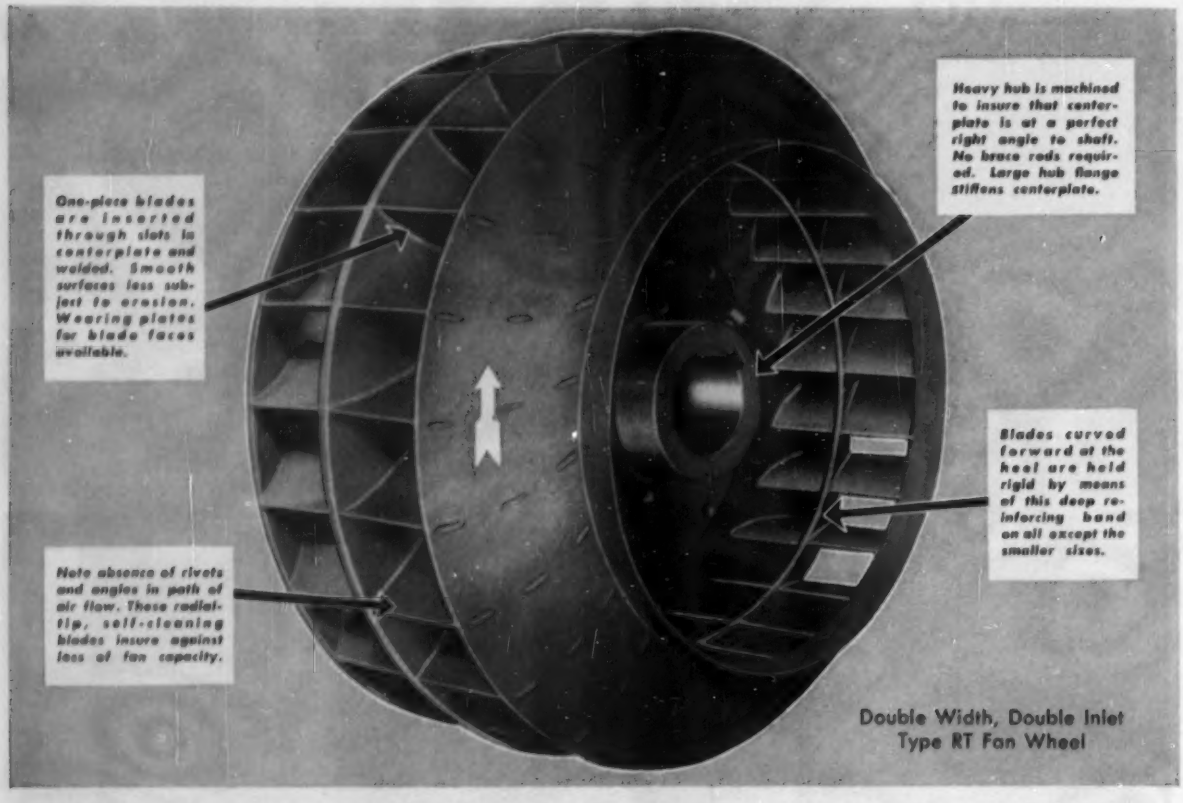
Name.....

Company.....

Position.....

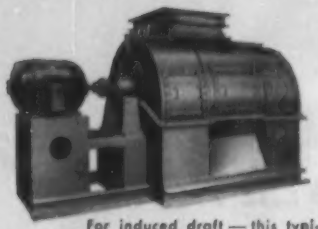
Address.....

City.....*Zone*.....*State*.....


One-piece blades are inserted through slots in centerplate and welded. Smooth surfaces less subject to erosion. Wearing plates for blade faces available.
Heavy hub is machined to insure that centerplate is at a perfect right angle to shaft. No brace rods required. Large hub flange stiffens centerplate.
Blades curved forward at the heel are held rigid by means of this deep reinforcing band on all except the smaller sizes.
Note absence of rivets and angles in path of air flow. These radial-tip, self-cleaning blades insure against loss of fan capacity.
Double Width, Double Inlet
Type RT Fan Wheel

Note these points of superiority

which distinguish CLARAGE's Type RT wheel



For induced draft — this typical Clarage Type RT fan.

For forced draft — this typical Clarage Type RT fan.

Choose Clarage mechanical draft equipment and first cost is your last cost for a long time to come. An important consideration.

Throughout, the Type RT fan is distinguished by **heavy construction.** It's built to defy the most punishing demands.

Of special importance is the superior wheel. Here, particularly, is where Clarage construction is vital to you.

In many other respects the Type RT fan is a "stand out." Learn about these distinguishing features in Catalog 901, or contact the nearest Clarage application engineering office.

Applications, specifications, and available arrangements are covered in this catalog. Send for your free copy today.

You can Rely on...

CLARAGE

Headquarters for Air Handling and Conditioning Equipment

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA Canada-Fans, Ltd., 4285 Rutherford St., Montreal

POWELL VALVES . . . THE COMPLETE QUALITY LINE . . . POWELL VALVES

. . . THE COMPLETE QUALITY LINE . . . POWELL VALVES . . . THE COMPLETE QUALITY LINE . . .

POWELL VALVES FOR POWER PLANTS

FIG. 375—Bronze Gate Valve For 200 Pounds W.S.P

FIG. 1793—Iron Body Bronze Mounted Gate Valve For 125 Pounds W.P.

FIG. 19003—900-Pound Pressure Seal Gate Valve

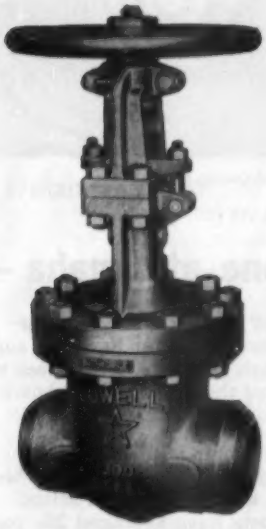


FIG. 3003—Steel Gate Valve For 300 Pounds W.S.P.

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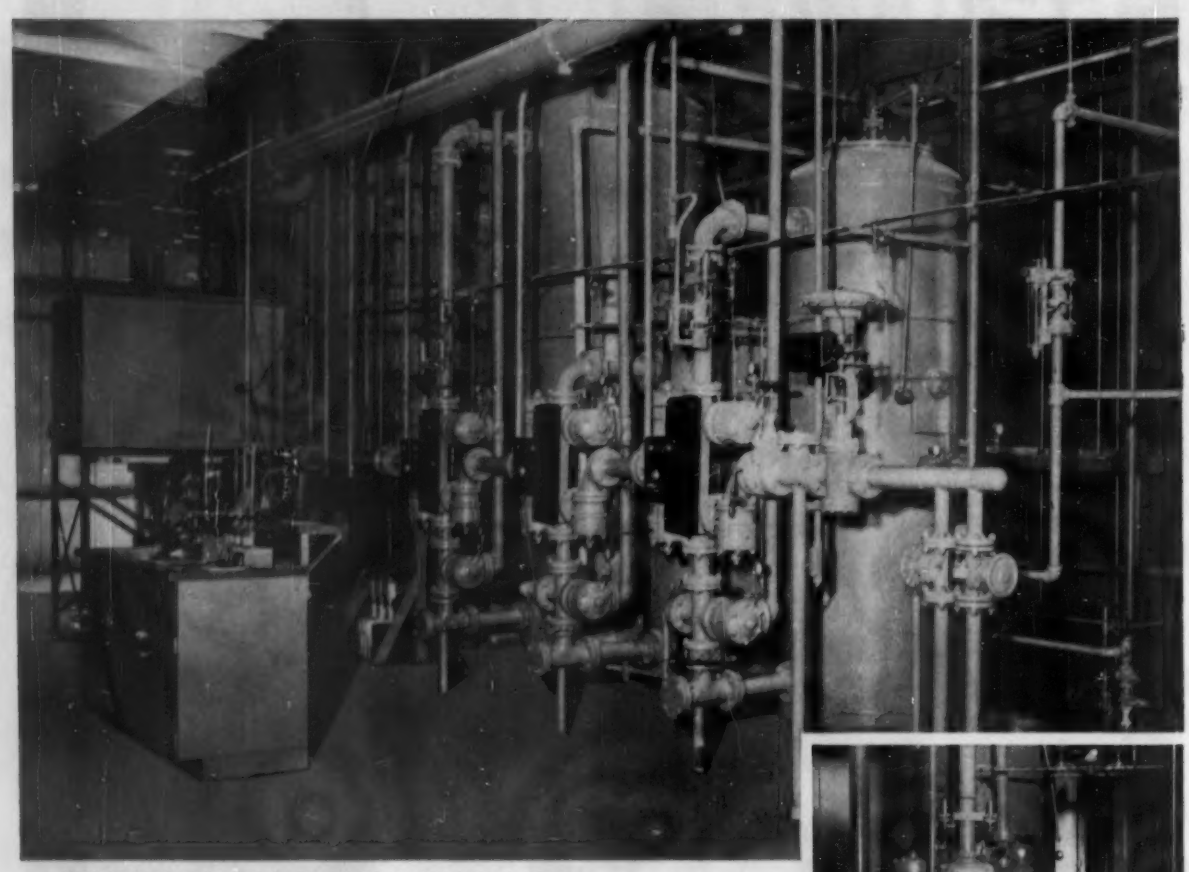
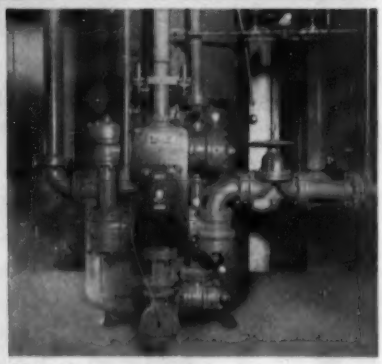


INFILCO Demineralization Plant installed at the North Omaha Station.



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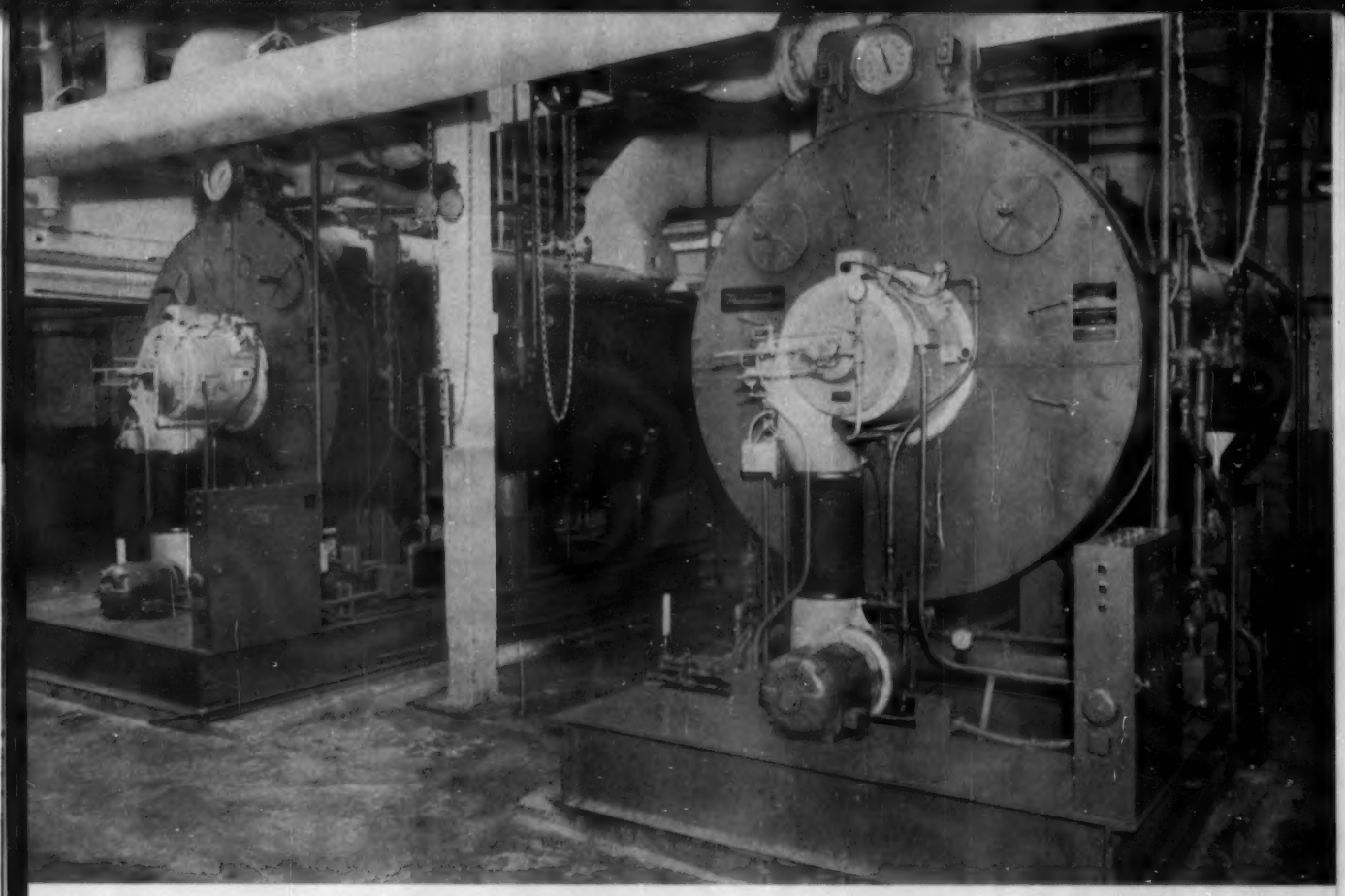

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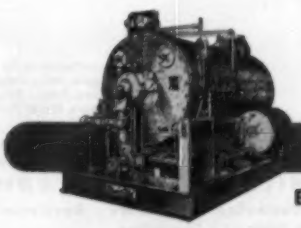

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'Slide-Rule Engineer'

THAT'S THE NAME often thrown at the engineer who depends on theory, lacks practical savvy.

But I'm thinking of it as a symbol for another kind of engineer—the man who thinks he can run a plant the same way he works out a heat balance. He's used to situations where he can dig out all the facts, apply suitable formulas, and come up with a nice, clean answer.

Unfortunately, managing a plant or bossing a job doesn't always fit that neat pattern. For one thing, many operating decisions must be made quickly, without full information. Often the answers aren't ideal—they're compromises, the best that can be reached under the circumstances.

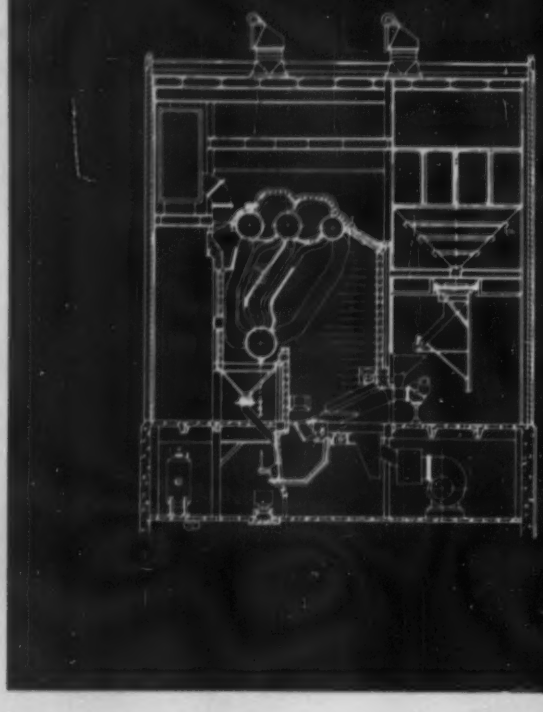
For another thing, bossing a job involves many angles. Somebody defined a boss as a man who gets results *through others*. That means people, and people rarely follow logical laws and formulas.

Psychologist H B Moore sums it up like this: "The typical engineer is prone to restrict his attention to observable fact and has a very real tendency to regard people (especially his subordinates) as complicated machines which are different from his tools primarily in two ways . . . harder to renovate and more costly to oil."

Now this doesn't mean that you should throw away the slide rule, give up trying to ferret out all the facts, abandon the effort to apply logical analysis. The so-called engineering approach is a good one—*where it fits*. The whole trick is to learn its limitations and accept them.

Just remember that you're going to have to make many decisions on scanty information, in situations where there isn't any simple formula. When you're in spots like these, you'll have to be satisfied with common-sense answers. Admit it and forget it—don't build up a nagging sense of frustration because you can't give the full analytical treatment to every problem.

And, most important of all, remember that working with people demands tolerance, patience, warm understanding of why they act in wonderful, wacky ways. Only when we learn to temper the engineering approach with horse sense and humanity can we be really successful in leadership.



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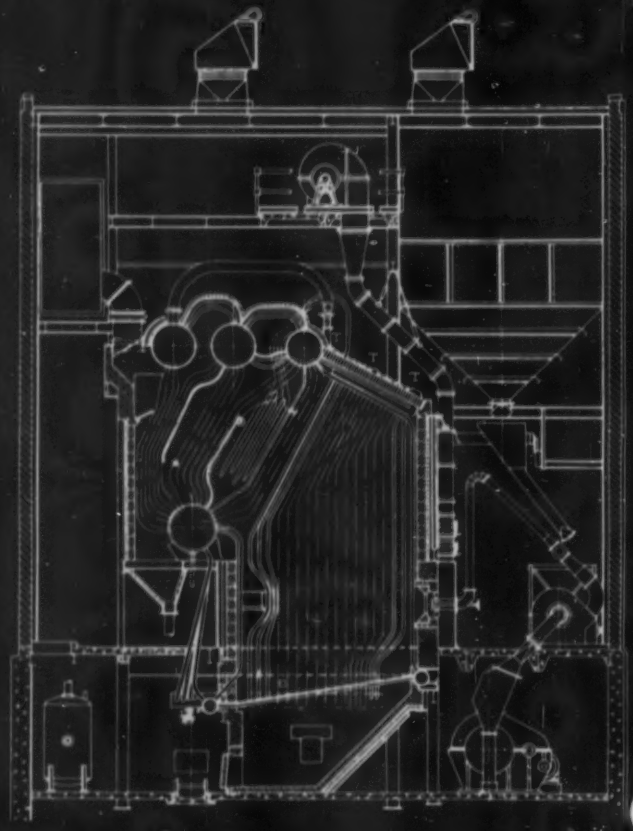

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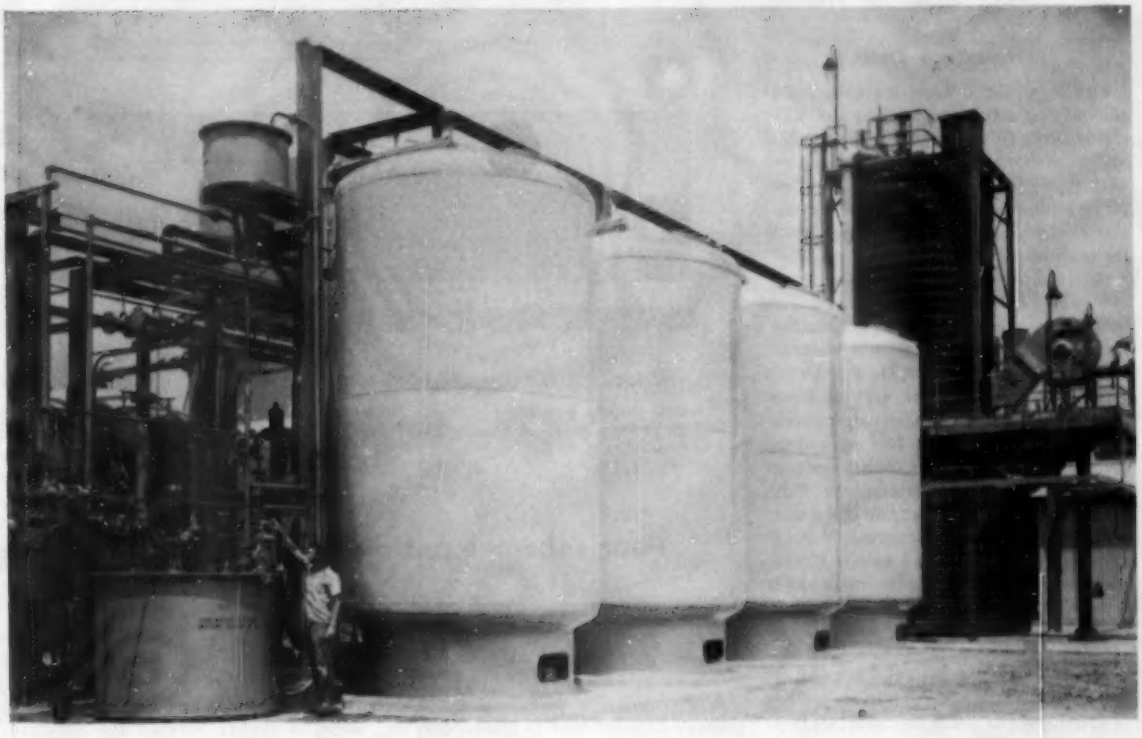


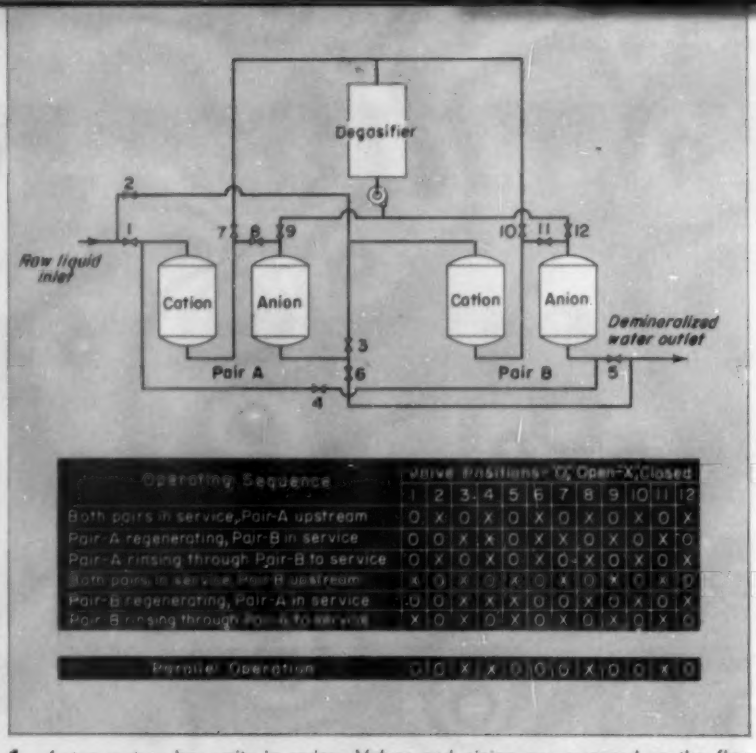
What's NEW in demineralizing

Basic operating principles are now well understood. So present demineralizer practice tends toward new arrangements to give: Best water at least cost • better controls • high efficiency

By **DURANDO MILLER**
Assistant Technical Manager
The Permutit Company

► DEMINERALIZING WATER by ion exchange has been in commercial use for over 15 years—but major developments in the process have taken place in the last six or seven years since strongly-basic-anion-exchange resins came into use. These resins' ability to remove silica as well as dissolved electrolytes from water opened the demineralizing field to boiler-feedwater treatment.

Demineralizers may be classed generally as 2-bed and mixed-bed. The 2-bed system has cation- and anion-exchange materials in separate units. Most common arrangement has hydrogen-cation exchanger followed by strongly basic anion exchanger. Mixed-bed unit has cation- and anion-exchanger materials mixed in a single tank. Much has been written about



Operating Sequence	Valve Positions—O, Open—X, Closed											
	1	2	3	4	5	6	7	8	9	10	11	12
Both pairs in service, Pair-A upstream	O	X	O	X	O	X	O	X	O	X	O	X
Pair-A regenerating, Pair-B in service	O	O	X	X	O	X	X	O	X	O	X	O
Pair-A rinsing through Pair-B to service	O	X	O	X	O	X	O	X	O	X	O	X
Both pairs in service, Pair-B upstream	X	O	X	O	X	O	X	O	X	O	X	O
Pair-B regenerating, Pair-A in service	O	O	X	X	X	O	O	X	O	X	O	X
Pair-B rinsing through Pair-A to service	X	O	X	O	X	O	X	O	X	O	X	O
Parallel Operation	O	O	X	X	O	O	O	X	O	O	X	O

1 4-step system has units in series. Valves and piping are arranged so the flow path can be changed. Valve chart shows setups for various flow arrangements

both types, and the major operating principles are now well understood.

Recently, considerable effort has been directed toward refinements to provide better water at less cost, easier methods of control and improved operating efficiency. We will talk about some of these refinements.

ALTERNATING SERIES

Quality of 2-bed demineralizing-plant effluent depends on amount of metallic-cation slippage through the hydrogen-cation exchanger. This slippage varies with type of cation exchanger, level of regeneration and composition of raw water. Demineralized-water conductivity runs about 10 to 20 micromhos as a result of the slippage. In some cases, values may be somewhat higher or lower than this range. (At 77 F, 10 micromhos show presence of about 2 ppm of caustic soda, expressed as $CaCO_3$.)

Mixed-bed demineralizers produce water of much lower conductivity, usually below 1 micromho. But operating cost is higher than for 2-bed system. There are two main reasons for this higher cost. First, anion resin has lower capacity in mixed-bed operation. And second, bicarbonates and free CO_2 are taken up by anion bed in mixed-bed system. These impurities, if present to any appreciable extent in the raw water, are removed by a degasifier between the cation and anion units in a 2-bed system.

Alternating-series 4-step demineralizing system gives an effluent almost as low in conductivity as the mixed-bed system at an operating cost comparable to a 2-bed system. This type consists of: a hydrogen-cation exchanger; a degasifier or vacuum deaerator (if bicarbonate and CO_2 in raw water make degasification necessary); a strongly basic anion exchanger; a second hydrogen-cation exchanger; finally, a second strongly basic anion exchanger, Fig. 1. Equipment is operated in series and can deliver an effluent having a conductivity in the range of 1 to 5 micromhos.

When upstream cation and anion units become exhausted, they are removed from service and regenerated. The remaining pair carry the load and produce water of 2-bed-system quality.

During regeneration, strongly basic anion exchangers must be thoroughly rinsed with hydrogen-cation-exchanger effluent to remove the last traces of caustic soda. To obtain high-quality effluent characteristic of the alternating-series system, caustic rinse must be even longer than with 2-bed system. This extended rinse can be avoided by the following procedure.

Four schemes put demineralizers in series—

When upstream pair have been regenerated, anion unit is rinsed only to point where solids content of the effluent is about the same as that of the raw water. This pair of units are then returned to the upstream position. Downstream pair further demineralize final part of anion rinse with improving effluent quality as upstream-anion-unit rinsing continues. This operation goes on until demineralized-water conductivity levels off at normal low value. Recently-regenerated pair are then changed to the downstream position. Extended rinse given anion unit while in upstream position removes last traces of excess caustic so final effluent stays low in conductivity. This method results in savings in rinse water and regenerating chemicals. It reduces operating time when only a single pair of units are in service and increases net output of installation.

Effluent from upstream pair, containing only a few ppm of dissolved solids, is then treated by freshly regenerated pair of units capable of reducing dissolved solids to a very low value. Since downstream pair have so little work to do, they remain essentially fully regenerated during their operation in the downstream position.

Degasifier or vacuum deaerator, if used, is always between the upstream pair of units.

Despite improved effluent quality produced by the alternating-series system, chemical needs per thousand gallons of treated water are no higher than with a 2-bed system, and are substantially lower than with a mixed-bed system.

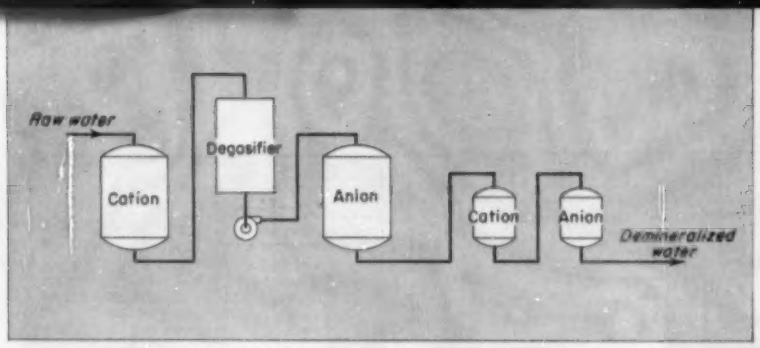
System is usually arranged so it can also be operated in parallel. This permits high rate of demineralized-water production (equivalent in quality to 2-bed system effluent). This is advantageous for initial boiler filling or to cover unprecedented peak loads.

In alternating series, the downstream pair act as a safeguard against dissolved solids or silica break-through should the upstream pair accidentally run too long.

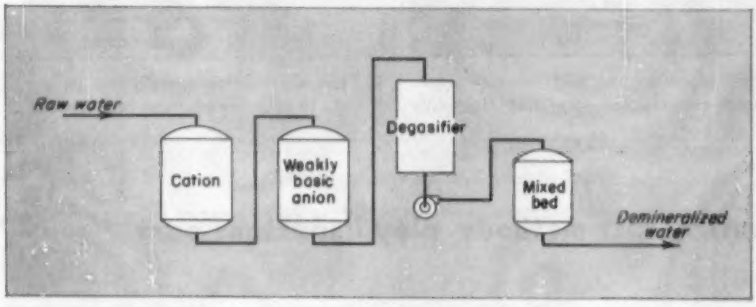
Transfer valves for reversing positions of unit pairs are usually controlled from a central regulator to simplify the operation.

POLISHING DEMINERALIZERS

Another 4-step-system arrangement uses hydrogen-cation exchanger followed by strongly basic anion exchanger



2 Series arrangement with the last two units used for polishing only. These smaller units need regeneration infrequently, and so add little to operating cost



3 Mixed-bed unit used here for polishing operation. Weakly basic anion exchanger takes care of mineral acidity at lower cost than would be so with strong base

another keeps flow high by recirculation

(with degasifier or vacuum deaerator in between if needed) and, following these, another pair of similar units, but smaller in size, Fig. 2. The last units stay in the downstream position. They serve the same purpose as the downstream pair in the alternating-series system. Since they are always operated on the effluent from the first pair, they can be operated at considerably higher flow rate without efficiency loss.

This system represents lower initial investment than the alternating series, yet produces equivalent-quality water. Operating cost is only slightly higher than for the alternating-series system, since downstream or polishing units need infrequent regeneration. But the system is less flexible. When upstream pair are regenerated, polishing units must also be removed from service. So if demand is continuous, there must be adequate demineralized-water storage or a duplicate set of upstream units.

MIXED-BED POLISHING

Operating cost is against the mixed-bed demineralizer, but it can produce higher-quality water than other types and is able to give this low-conductivity water almost immediately following shutdowns. Several arrangements are available to keep the advantages of mixed-bed treatment and still hold the operating cost down close to that for the 2-bed system.

One uses the usual 2-bed arrangement (with degasification if needed) followed by a polishing mixed-bed demineralizer. The mixed-bed unit requires infrequent regeneration. And since it is operating on demineralized water, it can use considerably higher flow rates than would be the case with raw water.

A second arrangement, Fig. 3, uses weakly basic anion exchanger in place of the strongly basic one above. In this case, degasifier or vacuum deaerator normally is placed after instead of before the anion unit. As above, the final step is the mixed-bed unit. Mineral acidity of the water is taken up by the weakly basic anion exchanger more economically than would be the case with the strongly basic unit. Reasons for this lower operating cost are that weakly basic unit has higher exchange capacity, better regenerant efficiency and can use soda ash (on a chemically equivalent basis, soda ash is usually less expensive than caustic soda).

Effluent from this plant will have essentially the same electrolyte content as first arrangement, but there is no silica reduction before the mixed-bed unit. So to insure thorough silica removal, the mixed-bed unit should operate at about normal flow rate.

Where theoretical mineral acidity (chlorides, sulfates and nitrates) in the raw water is a large part of the total anions, the second system is particularly attractive for both operating cost and initial investment. Weakly basic anion-exchange resin is considerably less expensive per cubic foot than the strongly basic resin, and less anion resin is needed.

COUNTERCURRENT REGENERATION

High regenerant efficiency is possible in some demineralizing systems if a countercurrent regeneration method is used. As an example, suppose we have a 4-step-series system consisting of primary hydrogen-cation exchanger and weakly basic anion exchanger, degasifier (if needed), and secondary hydrogen-cation exchanger and strongly basic anion exchanger.

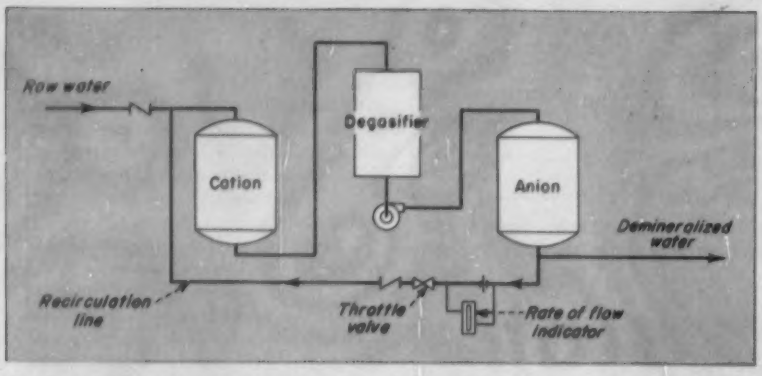
This system is particularly useful where theoretical mineral acidity is a large percent of the total anions. Primary hydrogen-cation unit removes the bulk of the metallic cations, and weakly basic anion unit takes the bulk of the anions. So secondary cation unit and strongly basic anion unit are relatively small.

When primary cation exchanger exhausts, both cation units are removed from service. Regenerating acid is passed through the two units in series, going to the secondary unit first. Amount of acid used is normal dosage for primary unit plus amount needed to take care of small cation pickup in the secondary. Since the secondary unit is relatively small, this amount of acid regenerates it completely, thus making topnotch performance during operation possible.

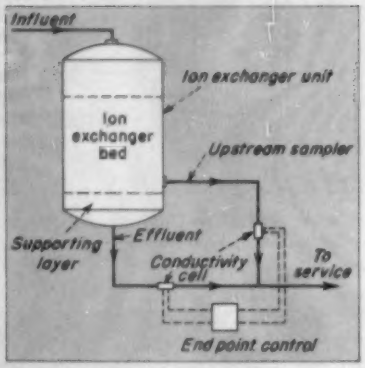
Same procedure is followed when weakly basic anion exchanger exhausts. Both anion exchangers are removed from service and caustic-soda regenerant is passed first through the strongly basic unit and then through the weakly basic unit.

Secondary cation and strongly basic anion units have bed depths for enough capacity so that neither unit is appreciably exhausted when removed from service for regeneration. This insures high effluent quality and protects against overrun of the primary units.

(*More on next page*)



4 Recirculating system permits running 2-bed plant at low flow rates or intermittently without impairing the water quality—this saves water and chemicals



5 Endpoint control system can be set up to initiate exchanger regeneration

Improvements in control, test methods play important part

GRAVITY MIXED-BED UNITS

Developed for large installations, this system uses gravity mixed-bed demineralizers. The open rectangular concrete basins are similar to gravity filter basins except that they are lined with suitable material to prevent pickup of impurities from the concrete. This installation permits substantial cost savings as compared to large rubber-lined tanks. And it makes observation of the separation and air-mixing steps possible during regeneration. It also provides ready access to parts for maintenance.

RECIRCULATION

Operating a 2-bed plant with strongly basic anion exchanger at a very low flow rate causes effluent conductivity to be higher than normal. A flow rate as high as one third of normal may result in excessive conductivity rise when unit is first put on the line after regeneration rinsing step. Toward the middle or latter part of the run, this effect would be noticed only at lower flow rates—about 10% or less of normal flow. But conductivity and, sometimes, silica are found to be above normal for some time after start-up following shutdowns. The longer the shutdown, the greater the conductivity increase.

Operating intermittently at higher rates and discharging inferior water to waste following each shutdown is one way to solve this problem. But this wastes water and chemicals and complicates plant operation.

Recirculation solves the problem without waste and without objectionable increases in conductivity or silica, Fig. 4. During periods of low or zero demand, sufficient water is recirculated to the inlet of the hydrogen-cation exchanger to keep conductivity at the normal level. Rate of recirculation is adjusted by a throttle valve and a flow-rate indicator.

No additional pumping equipment is needed if plant has degasifier or vacuum-deaerator transfer pump. If raw-water pressure exceeds transfer-pump discharge head, there must be a pressure-reducing valve on the raw-water inlet. With no degasifier and, therefore, no transfer pump in the system, a low-head recirculating booster pump is needed. In this case there is no need for a pressure-reducing valve.

As pointed out before, strongly basic anion exchangers require thorough rinsing with hydrogen-cation-unit effluent to remove last traces of caustic-soda regenerant. About 50% of the anion-exchanger rinse water can be saved by recirculating last part of rinse to hydrogen-cation exchanger inlet. This recirculation can start when dissolved-solids content of rinse has dropped to the level of solids in the raw water. Since recirculated water becomes purer as rinsing progresses, there is less reduction in cation- and anion-exchanger capacity than would be the case with straight raw-water rinse. This gives some savings in regenerant cost. Rinse is recirculated with same facilities used for recirculation during operation.

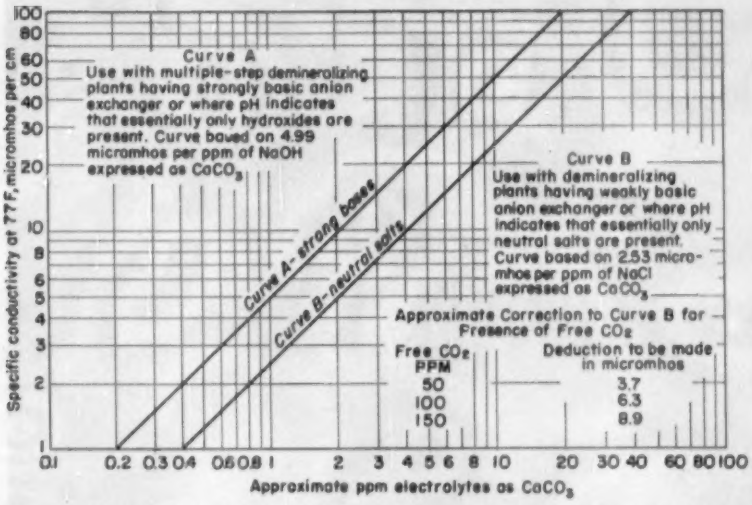
ENDPOINT CONTROLS

When a hydrogen-cation exchanger approaches exhaustion (more metallic cations slip through the unit) the free mineral acidity of the effluent begins to decrease. This decrease in free mineral acidity has usually been used to determine the endpoint of the run. The operator must, therefore, titrate effluent samples for mineral acidity. Where composition of raw water varies appreciably, several titrations may be needed for each run to insure the unit is not removed from service too soon or after it is overrun.

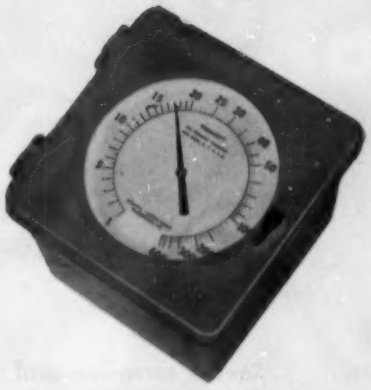
Strongly basic anion exchangers unfortunately do not show their exhaustion so readily. First there is a rise in silica content, followed by the appearance of CO_2 and then finally of mineral acidity. When silica appears in the anion-exchanger effluent, a conductivity indicator shows little or no change. By the time there is a substantial conductivity increase due to CO_2 and mineral acidity break-through, silica in the effluent may be extremely high. It might be even higher than that in the raw water because of silica being displaced from the bed by other ions.

Usual practice, therefore, calls for making silica determinations on the anion effluent. Unit is removed from service when silica begins to increase. These determinations are even more time-consuming than free mineral-acidity titrations for the hydrogen-cation exchangers. And unless it is done frequently, the unit may readily be discharging excessive silica before the operator finds evidence of exhaustion.

Where raw water has fairly constant composition or is subject only to gradual changes over long periods of time, both cation and anion exchangers are usually operated by setting their meters to a gallonage just short of exhaus-


Specific conductivity at 77 F, micromhos per cm
100
80
60
50
40
30
20
10
8
6
5
4
3
2
1
Curve A
Use with multiple-step demineralizing plants having strongly basic anion exchanger or where pH indicates that essentially only hydroxides are present. Curve based on 4.99 micromhos per ppm of NaOH expressed as $CaCO_3$
Curve B
Use with demineralizing plants having weakly basic anion exchanger or where pH indicates that essentially only neutral salts are present. Curve based on 2.53 micromhos per ppm of NaCl expressed as $CaCO_3$
Curve A- strong bases
Curve B-neutral salts
Approximate Correction to Curve B for Presence of Free CO_2
Free CO_2 PPM
Deduction to be made in micromhos
50 3.7
100 6.3
150 8.9
0.1 0.2 0.3 0.4 0.6 0.8 1 2 3 4 5 6 8 10 20 30 40 60 80 100
Approximate ppm electrolytes as $CaCO_3$

6 Chart keyed to conductivity readings gives approximate dissolved solids for two separate conditions—when anion exchangers are strongly basic or weakly basic



7 Conductivity instrument gives water quality at glance, initiates controls

tion. Free mineral acidity and silica are checked occasionally to prevent overrun. Where raw-water variations are more rapid, meter control calls for setting gallonage to take care of worst anticipated raw-water conditions. With this setup, full plant capacity for the run is not realized when raw-water conditions are good.

Hydrogen-cation exchanger control by effluent pH readings has been suggested. But pH changes are small as end of run approaches. And this scheme bypasses the fact that changes in raw-water composition give variations in effluent free-mineral acidity. So false exhaustion indications may be given.

pH endpoint control has also been proposed for anion exchangers on the strength of the fact that when, or shortly after, silica begins to break through, CO_2 begins to slip through and pH decrease is noted. If exhaustion of the cation exchanger is taking place at the same time, however, anion-effluent pH may stay fairly constant or even increase.

There is an endpoint-control system that readily gives the endpoint of either the hydrogen cation or strongly-basic-anion-exchanger run. For the cation unit, effluent conductivity is compared with that of a sample drawn from a point a few inches above the bottom of the exchanger bed. During the run, both conductivities are essentially the same. But as exhaustion approaches, metallic cation content increases while hydrogen-ion content decreases at the upper sampling. This results in a decrease in conductivity at this upper point, and the ratio of the two conductivities shows a substantial change. System can be arranged to actuate an alarm or initiate regeneration, Fig. 5.

A modification of this same principle is used for the strongly basic anion exchanger. Conductivity of a sample drawn a few inches above the bottom of the bed remains constant during the run. But as exhaustion approaches, mineral acidity causes conductivity at this point to increase very rapidly. Sampling-point location depends on ratio of silica to other ions present in the water. With proper location, there is a sharp increase in conductivity before any substantial rise in effluent silica takes place. Again, system can be set up to actuate alarm or initiate regeneration.

Arrangement described for strongly basic anion exchangers is used for mixed-bed units. It will show exhaustion regardless of whether cation or anion resin exhausts first. In either case, conductivity increases in bed sample before there is any substantial rise in effluent conductivity or silica.

EXPRESSING QUALITY

Previously it was customary to express effluent dissolved solids in ppm. Conductivity meters were calibrated in terms of ppm of NaCl, expressed as $CaCO_3$. This was fine for the 2-bed system using weakly basic anion exchangers. Effluent contained primarily sodium bicarbonate, sodium chloride and sodium sulfate, all of which have about the same conductivities. So value read on meter was close approximation of actual dissolved electrolyte content.

But it is very much in error to express strongly-basic-anion-exchanger effluent conductivity as ppm of NaCl. Here effluent primarily contains sodium hydroxide which has a conductivity roughly twice that of neutral salts. So conductivity meter reads about 100% high.

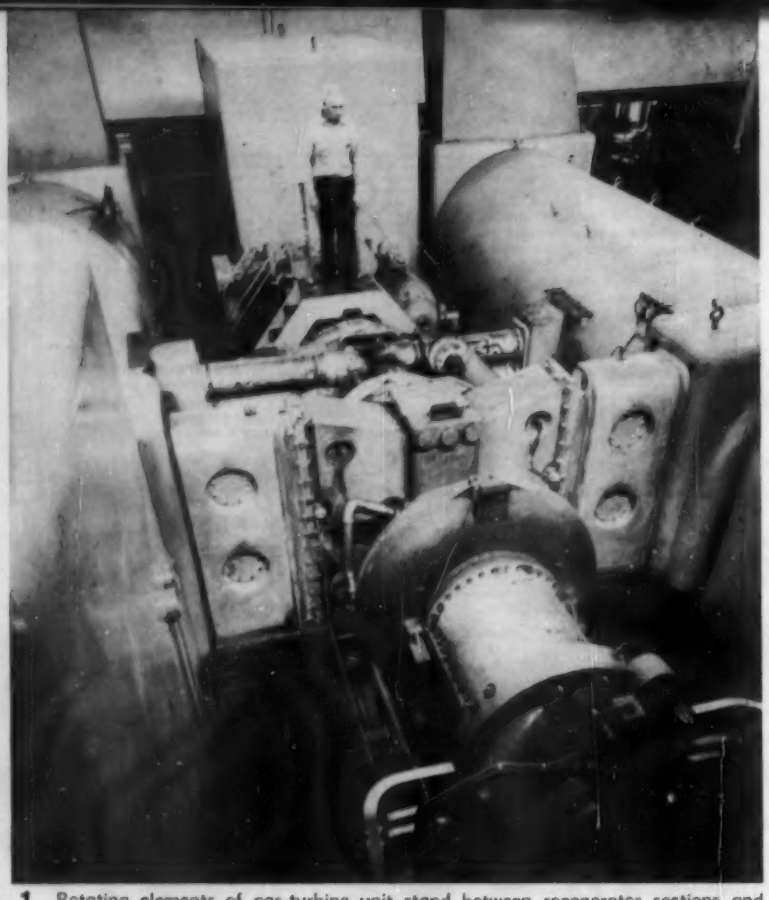
Development of the mixed-bed demineralizer introduced conductivity as a means of expressing (as well as measuring) effluent dissolved-solids content. Determining the minute amount of dissolved solids in the mixed-bed effluent is entirely impractical by any but the most refined and elaborate analytical methods. So it has been customary to express effluent quality in terms of conductivity. This is also the usual practice with steam condensate of high quality.

It also seems consistent to express 2-bed-system effluent quality in terms of conductivity. Then with graphs or tables, the operator can determine the corresponding ppm of dissolved solids, depending on whether anion exchangers are strongly or weakly basic, Fig. 6.

Of the dissolved solids present, the operator is concerned primarily with hardness and silica. Accurate methods for determining these, in very low concentrations, are now available.

Until recently, "magic-eye" electron-ray-tube conductivity instruments were most commonly used for demineralizing plants. Readings with this instrument are obtained by adjusting a knob to give the narrowest band in the magic eye. There is now available a conductivity instrument that gives continuous readings without having to adjust a knob, Fig. 7.

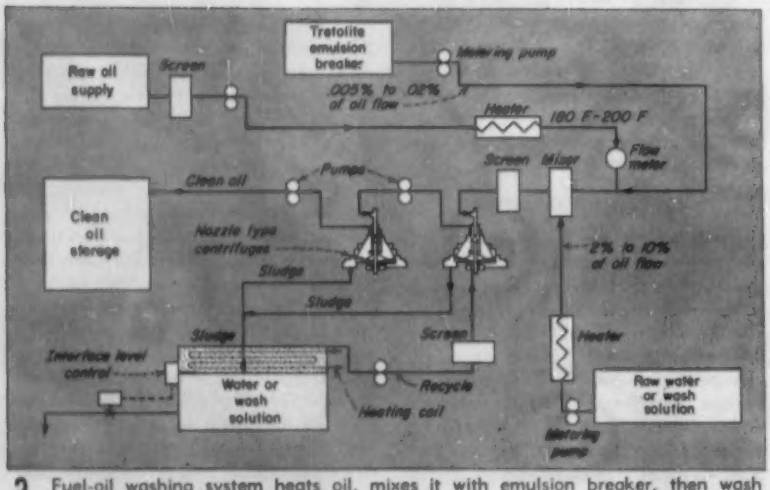
By D M Landis, *Manager*
Marine Division
The De Laval Separator Company



Severe corrosion and slag deposits threatened to rob gas turbines of their principal claim to economical operation: the ability to burn residual fuel oils. A remedy was urgently needed to save the day, so now a . . .

1 Rotating elements of gas-turbine unit stand between regenerator sections and intercoolers at sides: l-p compressor in center foreground, generator at rear

Washing system cleans up residual

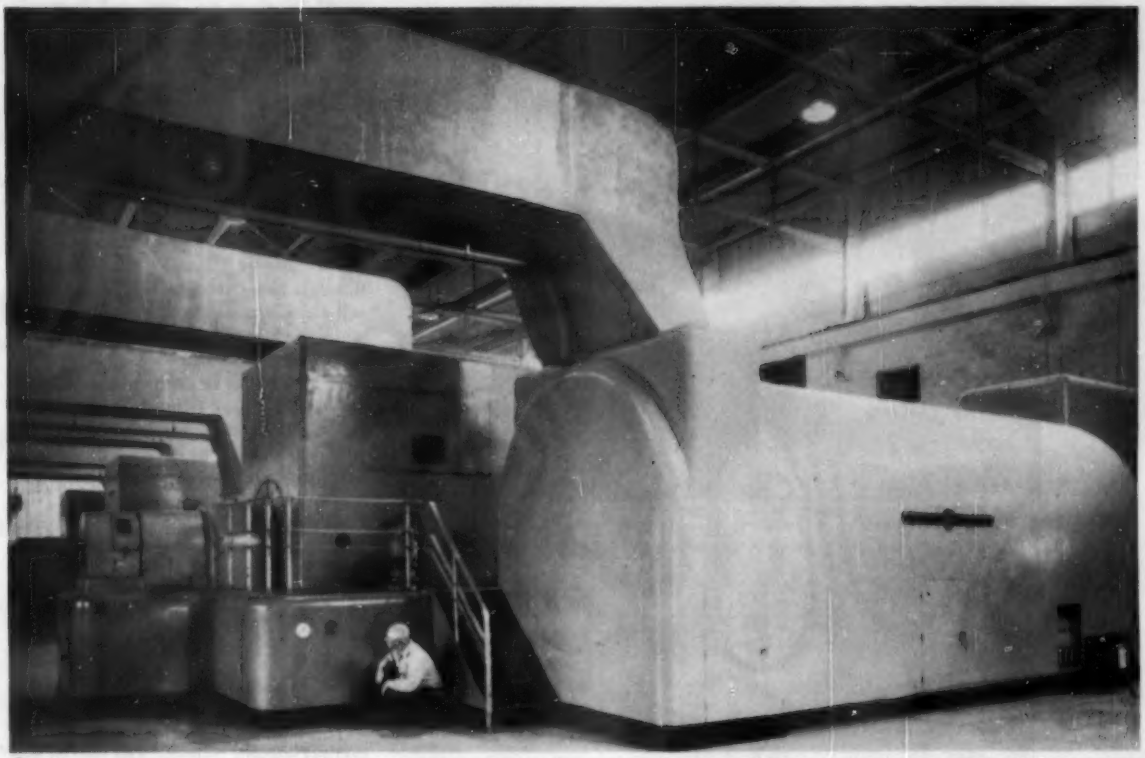


3 Fuel-oil washing system heats oil, mixes it with emulsion breaker, then wash solution, passes it through two centrifuges, and finally stores it in oil tank

► When residual fuels were first burned in high-temperature gas turbines they severely corroded turbine parts and deposited ash. Vanadium and sodium in the ash cause the corrosion, so methods of inhibiting or removing them had to be developed. Adding chromium compounds, usual inhibitors for sodium, augmented slag formation. So sodium had to be removed from the fuel by first washing it and then separating out the water by centrifuging.

Once rid of the sodium, an additive was needed to prevent vanadium corrosion and to form a nonsticking ash. This proved to be a water solution of magnesium sulfate, thoroughly mixed with the fuel to form an emulsion. About three million gallons of fuel treated this way have been burned at the Rutland Plant of the Central Vermont Public Service Corporation in its three General Electric gas turbines.

Research jointly by General Electric Company, The De Laval Separator Com-



2 Rutland Station's three 5000-kw gas-turbine units stand side by side. *Left to right:* exciter, main generator, regenerator (2 per unit), intercooler (2 per unit). Exhaust ducts from top of regenerators lead cooled gas to station stacks

fuel for low-cost gas-turbine operation

pany and the utility at this plant developed fuel specifications and operating procedures that made it possible for gas turbines to burn residual fuel oil. The three 5000-kw units were installed in 1951 to run on No. 6 oil. It was two years later before a satisfactory method of fuel treatment was developed.

Research program. GE Co started laboratory investigation of oil-ash corrosion in 1948 shortly after a first-stage nozzle in a locomotive gas turbine failed. This continuing current program uses two tools of investigation: (1) crucible tests and (2) small-burner tests. Work on corrosion was first undertaken because it was more important than the ash deposits. Corrosion affected turbine operation before ash deposits interfered substantially, so possible cures for corrosion had to be found before an effective attack on ash deposits could be made.

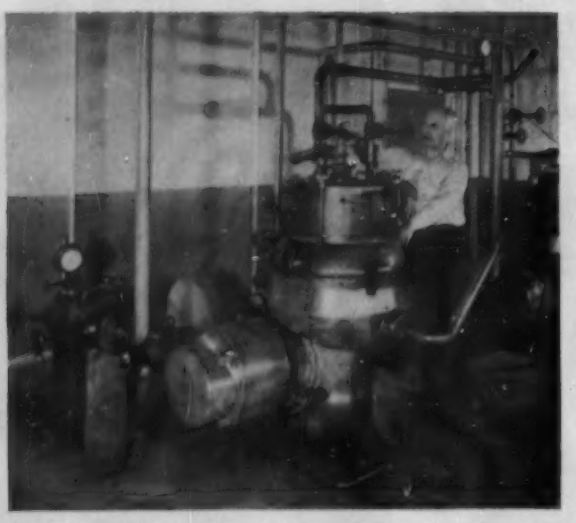
This work showed that satisfactory life could be obtained by adjusting the ash constituents with additives and properly choosing the turbine-part alloy. A fuel specification defining the ash constituents' relationship was proposed. This specification (1) used calcium as an additive to inhibit vanadium pentoxide corrosion, and (2) maintained ratio of sodium to vanadium in the fuel at 0.3 or less to prevent corrosion by sodium sulfate.

A sufficient number of additives have been tried to define the cures for corrosion. This allowed attacking the deposit phase of the problem. This work still continues, so new information and experience may warrant a modification of the proposed fuel specification.

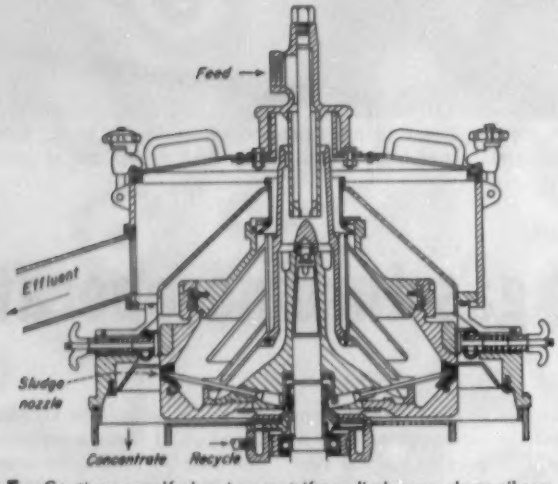
Oil treatment. Oil delivered on the Eastern seaboard has been very bad because of naturally contained sodium and salt-water contamination in tanker transportation. This condition also plagues marine and utility boilers because of boiler and superheater deposits and sometimes superheater corrosion. Although uninhibited vanadium causes corrosion, it inhibits corrosion by sodium sulfate. This is the reason for the 0.3 ratio of sodium to vanadium.

Since this was hard to attain in some oils, additives were sought to inhibit sodium sulfate corrosion when the sodium content was high. Adding chromic acid was satisfactory for corrosion but it produced extremely hard and rapidly accumulating deposits.

After it became clear that sodium in the oil markedly increased rate of deposit accumulation, reduction of sodium content at point of use was undertaken. Several methods of removing the salt and reducing the sodium content of the oil to about 4 to 5 ppm have been developed. They consist of mixing water or a salt solution intimately with the oil and then centrifuging the mixture. The wash solution picks up most of the sodium in the oil. There must be a density difference of 3 to 4% between oil and wash solution to separate them by



4 Two centrifuges of oil-washing system need only part of one man's time to operate and keep in running condition



5 Continuous self-cleaning centrifuge discharges clean oil vertically upward, sludge through nozzles in the bowl rim

centrifuging. Since some residual oils are about as dense as water, a water solution of salt, such as magnesium salt, must be used to increase the density of the wash.

Oils desalted in this way show that both sodium and calcium promote ash deposits. Reducing sodium from about 100 ppm down to 5 to 7 ppm decreases deposit accumulation severalfold for oil containing about 150 ppm of calcium. Reducing the calcium from 150 to about 5 ppm further reduces deposit accumulation.

One gas turbine, burning oil with about 6 ppm calcium and 4 ppm sodium, has run for 3000 hr with a decrease of only 3% in effective flow area of its first-stage nozzle. This decrease occurred in the first 350 hr. Before reducing sodium and calcium in the oil the decrease in effective area was about 30% in about 60 hr. When reducing the sodium but not the calcium, the area reduction was 10% in 60 hr. Fortunately in the 1650-F range, magnesium is a better inhibitor of vanadium than calcium.

Centrifuging. The most important development during the last year has been the adaptation of the De Laval heavy-fuel-oil purifier, Fig. 5, to this problem after five years of research. This equipment helps modify residual fuel oil in the plant burning it. Washing the fuel at the plant reduces the sodium and inhibits the vanadium by adding magnesium salts.

The centrifuge, heart of the washing system, discharges (1) clean oil at the top of the bowl and (2) a sludge of oil, wash solution and suspended solids through a number of small nozzles at its periphery. Flushing the solids out through these nozzles makes the bowl self-cleaning; it can run indefinitely without shutting down.

Fig. 3 shows the washing system. Raw fuel oil is heated, mixed with an emulsion breaker to improve separation in the sludge tank and centrifuge, mixed with wash solution, passed through two centrifuges in series and then stored in the clean-oil tanks ready for use. Nozzle discharge from both centrifuges goes to a settling tank from which the upper layer is continuously pumped back to a special inlet in the bottom of the first centrifuge. The oil-rich part of the sludge recirculates again and again until all the oil is removed. Solids collected in the bottom of the sludge tank are periodically drained out.

This system at Rutland handles 45,000 gal per day, requires but part of one man's time to run, costs about $50,000, and can produce pure oil at a net (including equipment writeoff) of ¼ to 1/3 cent per gal.

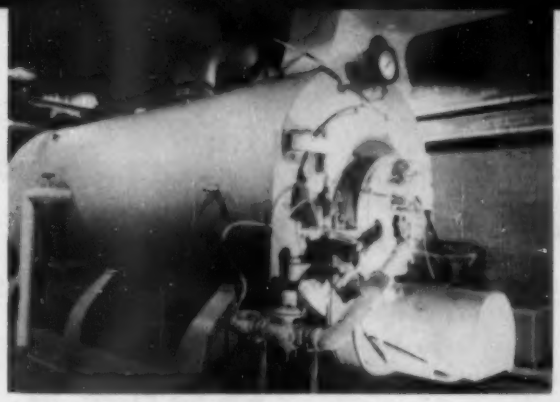
On the basis of this experience the Bangor Hydro-Electric Company is installing a similar system in its gas-turbine station.

Savings. When trouble with No. 6 oil first arose, Rutland was forced to burn No. 2 oil. This lasted all during the research period. No. 2 oil costs 11c per gal against 7c for No. 6. With each unit burning about 500 gal per hr, the difference in operating cost is $20 per hr per unit. This makes the original cost of $50,000 for the entire washing system seem incidental in the over-all picture.

The Rutland Plant receives No. 6 oil in tank cars. Usually six 12,000-gal cars are processed at a time through the fuel-oil treating system. The clean oil accumulates in two 300,000-gal storage tanks. The system was designed to handle 1800 gal per hr and has been tested up to a rate of 2000 gal per hr. With larger pumps and auxiliaries this same system could treat some oils at higher rates if needed.

This system could be easily applied to No. 6 oil being burned in high-temperature boiler furnaces. This would minimize or eliminate corrosion and ash accumulation caused by vanadium, sodium and calcium in the oil.

Station heating boilers speed up job of getting plant on line



STATION HEATING BOILERS generate saturated steam for building heating when the main steam generators are shut down

Here's how you can save time and money by using equipment for several purposes

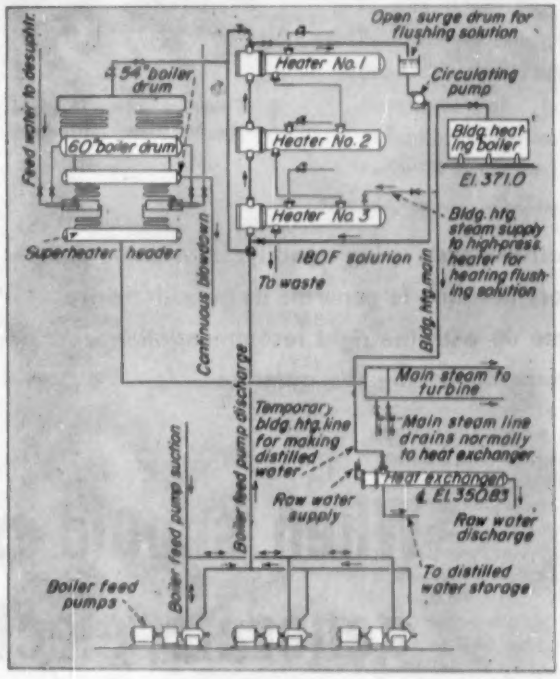
By E FLOYD THOMAS
Power Plant Superintendent
Johnsonville Steam Plant, TVA

► IN STARTING UP new plant equipment many problems arise that must be handled quickly, safely and economically. We had a very close construction schedule for the first unit at Johnsonville to relieve an acute power shortage on the TVA system. As we came nearer the starting date we explored many methods to accelerate preliminary operating schedules. These would help to get the first unit into commercial operation at the earliest opportunity.

Heater cleaning. One of the early problems was the chemical cleaning of the feedwater side of the high-pressure heaters to remove foreign matter such as dirt, scale, insoluble oils and greases. These sometimes remain in heater passages after fabrication and assembly of the equipment.

We needed a quick method of heating the chemical flushing solution. It was easy enough to hook up a circuit through the feedwater side of the heaters to carry the solution that would be recirculated by a pump. The solution had to be heated to about 186 F to do an effective cleaning job.

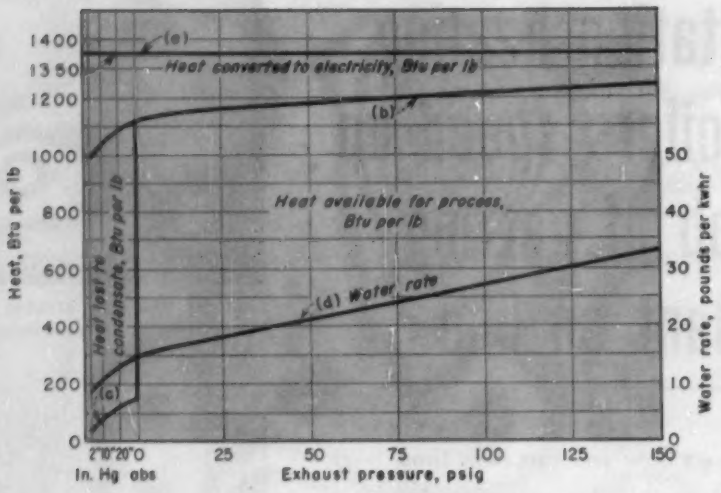
A little study showed that we could run a short branch line off the building space-heating main into the shell of No. 3 high-pressure heater, as shown in the flow diagram above. Two 6900-lb-per-unit steam generators supply the station heating system, one boiler is shown in the photo above. Steam from one of these boilers easily heated the flushing solution to 180-200 F. A temporary pump circulated the heated solution, which did a thorough internal tube-cleaning job. The condensate from the heater shell drained to waste, see diagram.



SIMPLE TEMPORARY HOOKUPS adapted the station's heating boilers to heating a chemical solution and making pure water

Distilled-water supply for initial starting of the main steam generator was another problem we had to meet. This water would be needed after the main boiler was "boiled out" for cleaning of drum and tube interiors. Here again we took advantage of one of our building-heating boilers. A closed raw-water-cooled heat exchanger, tied into the main superheater-header drain, cools the drains during unit starting and shutdown procedures. This exchanger was used to condense steam evaporated by one of the heating boilers. The distilled water drained from the heat exchanger into the distilled-water storage well. This arrangement gave us an ample supply of pure water for our initial unit start-up, quickly, safely and economically.

By using our two heating boilers for these preliminary jobs we gained another advantage: They gave us an opportunity to run early performance tests on these two boilers. If they hadn't been used for these purposes we would have had to run separate performance acceptance tests later.



1 Effect of various backpressures on turbine-generators using 600-psig, 700-F throttle steam. If process is used as condenser, electricity costs are minimum

With investment costs rising steadily, smart management thinks twice before deciding to generate its own electricity. If it's your job to come up with the right recommendation, consider these points before answering the question . . .

When should industry generate electricity?

By M L JONES, *Principal Power Engineer*
E I DuPont de Nemours & Co, Inc

► WHENEVER the industrial engineer starts planning a plant expansion or new plant construction, he comes to grips with several basic decisions. And one that's near the top of the list is: Should we include a power plant or should we buy needed steam and electrical power?

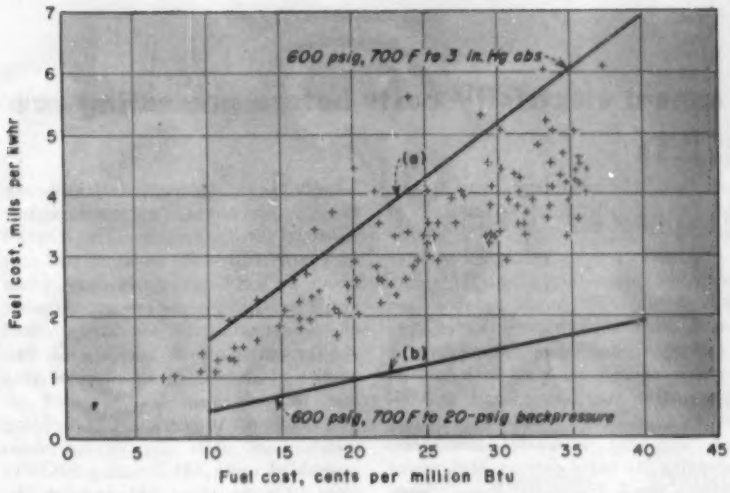
Naturally, the answer doesn't come easy. But a step-by-step study of the factors involved will usually lead to the right answer. We've tabulated the most important elements at top of facing page. In addition, you'll want to consider local conditions—those that apply to your plant only.

Based on 1955 American Power Conference paper

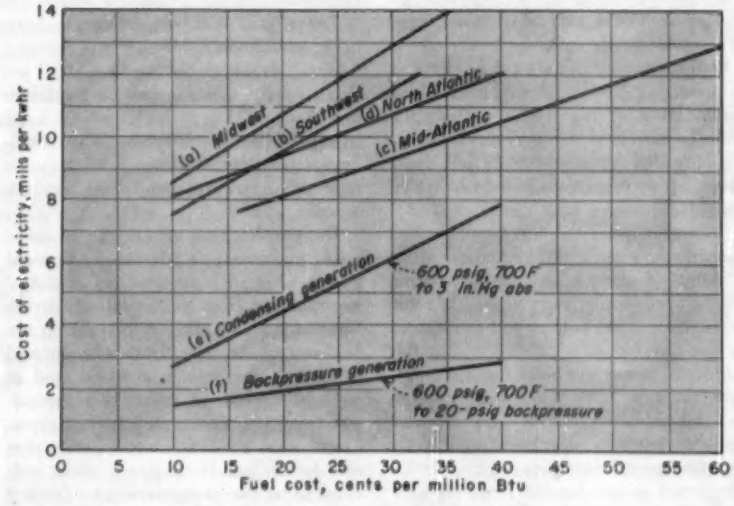
While other power services — compressed air, water, brine, refrigeration, inert gas — are also the industrial power engineer's responsibility, we'll narrow the problem down to steam and electricity. Only in rare cases can the other power services be bought. But they do have an effect on your final decision to buy or generate. The power needs of these facilities are part of the design of the industrial power plant, and their steam and electricity requirements are part of your over-all load.

Final decision is based on necessity and economics. Smart management insists that any $ investment show a reasonable return. And the power engineer is always competing with the production engineer for his company's available investment $$. What happens? Management invests where the return is greatest.

Reliability, availability. Here are a couple of items you can't overlook and still come up with a sensible answer. With the trend in industry toward continuous processes, more uniform quality, greater production and less semi-fin-


600 psig, 700 F to 3 in. Hg abs
(a)
(b)
600 psig, 700 F to 20-psig backpressure
Fuel cost, mills per kwhr
Fuel cost, cents per million Btu

2 Fuel cost, mills per kwhr, vs fuel cost, cents per million Btu for 5000-kw condensing (a) and backpressure (b) machines. Points are costs for utilities


(a) Midwest
(b) Southwest
(d) North Atlantic
(c) Mid-Atlantic
(e) Condensing generation
600 psig, 700 F to 3 in. Hg abs
(f) Backpressure generation
600 psig, 700 F to 20-psig backpressure
Cost of electricity, mills per kwhr
Fuel cost, cents per million Btu

3 Effect of geographical location on costs of typical utilities companies. Low fuel-cost areas don't necessarily have the lowest purchased-electricity costs

ished inventory, uniform and uninterrupted power services are a must. Outages or off-standard voltage and frequency can mean large production losses. In some industrial processes, installation of generating equipment can be a must item on this score alone—regardless of economics.

Buying steam has its limitations since it can't be delivered over long distances. Occasionally, where industrial plants are next to a utility, steam purchasing arrangements can be worked out. But here are some problems you're likely to run into: (1) Utilities usually don't have rate schedules for steam. (2) Selling steam may (a) upset the utility's heat balance or water-treating facilities or (b) limit the utility's electrical capability. (3) Available steam pressure may not suit your needs. Yet there are numerous examples of companies buying steam. And the arrangements benefit both the company and utility.

Getting to the core of the problem: Should you buy or generate electrical power?—first step is a detailed study of steam-electrical power load curves for your plant. In existing plants, where power needs are known, you're likely to have load curves on hand. But if you're dealing with a new plant—with new processes and equipment—you'll have to develop preliminary load curves, including average and peak loads, as well as seasonal. It may be necessary to work up daily and even hourly load curves, if expected load consists of batch or cyclic processes.

With load curves set up, next step is to take a close look at fuel costs for your area as well as estimated costs for purchased electricity.

If reliability and quality of outside power look OK, the problem boils down to simple economics—**$$**. And you'll find it tough to justify electrical-power generation with condensing turbines, especially if you're looking for quick payout time—a situation that's common in industry.

But where the process needs both steam and electricity, a chance to generate byproduct power—with extraction, mixed-pressure or backpressure turbines—enters the picture. Result: Economics may favor self-generation.

Byproduct power. Take a close look at Fig. 1. It shows the effect of operating a turbine-generator at different backpressures. Throttle steam is 600 psig, 700 F. Line *a* shows heat in throttle steam, 1350 Btu per lb. Line *b* shows exhaust heat leaving the turbine at different backpressures. Line *c*

HERE ARE ITEMS TO CONSIDER

Purchased electrical power

- **Availability**
- **Reliability**
- **Load curve**
- **Annual operating cost**
- **Potential expansion**

Generated electrical power

- **Load curve**
- **Fuel cost and selection**
- **Process continuity needs**
- **Investment cost**
- **Annual operating cost**
- **Potential expansion**

Develop comparative annual electricity costs before presenting your

shows heat in condensate at pressures below atmospheric.

Areas between these lines tell an important story. Area between *a* and *b* shows the heat converted to electrical power. Line *b* to *c* is heat lost in the condenser — an item that must be charged against electrical power. Area between line *b* and the horizontal axis shows heat available for process use where steam first passes through backpressure or extraction turbines or both. Line *d* is the water rate, lb per kwhr, over a range of backpressures. And here's the story's moral: If possible, use the process as a condenser for a backpressure turbine-generator. You then generate electricity as a byproduct of process steam, at minimum fuel cost. You're no longer throwing away heat shown in big area between lines *b* and *c*.

But when generating byproduct electrical power the question comes up: How much of the Btu cost for steam and electrical power should you charge to steam users, and how much should you charge to electrical power users? Here are two schools of thought: (1) Distribute fuel cost on a straight enthalpy or Btu basis, the method we'll use throughout this article. (2) Distribute fuel cost according to loss of available energy. This method charges more for steam at higher pressure—even though it may have the same heat content as steam at a lower pressure. There's no real agreement on which method is best.

In any real situation you have to assume a synthetic plant load. Let's start with a 5000-kw electrical load and an 80% load factor. To simplify the problem further, we'll also assume that the proposed boiler plant has an 85% boiler efficiency, and that 15% of the generated steam goes to boiler auxiliaries: fan drives, boiler-feed-pump drives, feedwater heating and other uses.

Fig. 2, based on our assumptions, shows fuel cost, mills per kwhr, vs fuel costs, cents per million Btu, for a 5000-kw condensing unit (curve *a*) and a 5000-kw 20-psig backpressure unit (curve *b*). Maze of points between *a* and *b* shows fuel costs for utility plants, from the Federal Power Commission's 1953 report.

Other costs figuring in the evaluation of purchased vs generated electricity include operating labor, maintenance labor and materials, supplies, replacement, depreciation and investment return, capital investment, and taxes. Here, in brief, is what you're likely to find:

For most areas operating labor rates for power plants are about the same. Since industrial power plants are smaller than their big-brother utilities it looks as though labor cost, per unit of energy produced, is higher for industrial plants. One man can operate a 2000-kw machine or a 50,000-kw machine. But with the industrial-plant crew spreading its costs over several power services, the $ differential doesn't loom as large as it appears at first glance.

Maintenance costs for industrial and utility plants are in the same range. The same holds true for supplies, although they're a relatively minor item in the total power cost.

Replacements can't always be charged to operating costs. They're basically a combination of big dollar outlays for maintenance, obsolescence, or just wearing out. But replacement charges don't shape up as big expenses when they're spread out over a long time.

Depreciation is the percent of capital investment written off annually—often a point of discussion. Utility power plants operate for many years. It's not uncommon to see boilers and generators on the line for 30 to 50 years. But the industrial power engineer faces a tough problem if he tries to sell management on this idea. Common depreciation rates range anywhere from 3 to 10%, and for special cases, as high as 20%. The trend to accelerated rates for new investments hasn't simplified the engineer's problem.

Return on investment plays a key role in the decision to buy or generate electrical power. It's up to management to decide if the return on their investment is reasonable, when compared to other investments they might make in process facilities. So the industrial-power engineer is always competing with the production engineer for available investment dollars.

To present a really attractive industrial-power proposal to management, think in terms of the minimum investment needed to provide facilities. This means rating and operating equipment at maximum loads—consistent with reliability and low maintenance. The *gravy* factors are tossed out.

Methods that are sound and economical in utility practice can't be blindly copied by the industrial-power engineer who hopes to get management's approval for his projects. The controls of a large boiler, for instance, will cost about as much money as those for a small boiler, if you use the same number of components. It's not hard to find similar examples. So take a good look at design details to keep investment costs to a minimum.

Other items to check are: (1) using standardized units (2) buying shop-assembled units (3) locating facilities close to using areas (4) burning the fuel that results in lowest over-all fuel cost—including fuel and ash-handling investment (5) eliminating building, excessive and nonproductive space.

Taxes, that item over which you have no control, can often be the decisive factor. In high-business-activity periods, capital dollars may be available, but the tax rate is high, so it's hard to show high return rates. When business activity is low, tax rates may be more attractive but capital dollars are scarce.

Geography also affects the economics of purchased vs generated electrical power. Fig. 3, curves *a*, *b*, *c* and *d* were figured from published rate structures of typical utility companies in the Midwest, Southwest, North Atlantic and Middle Atlantic, for a 5000-kw load at 80% load factor. Curve *b* is a natural-gas area. Others are mainly coal areas. Curve *e* is the calculated production cost for an industrial power plant with condensing turbine-generators. Curve *f* is the calculated production cost for an industrial plant with 20-psig backpressure turbine-generators. For both, throttle steam is 600 psig, 700 F.

Fig. 3 shows that: (1) Low-fuel-cost areas don't necessarily have the lowest power costs. Plant size, transmission-line length, load-area concentration, substations and other items affect the over-all picture. (2) Industry can't expect to compete with utilities if electricity is generated only by condensing turbines. (3) Low-fuel-cost areas favor industrial generation.

Electrical load type is another big factor you'll want to consider. The comparisons we just made were based on a 5000-kw load at 80% load factor. If your operation is an 8-hour day, 5-day-week process, load factor is low and unit cost for purchased electricity is high, because of the demand-charge ef-

fect. But the industrial power plant is also penalized in such circumstances. While its unit operating cost is low, kwhr generated annually by the industrial power plant are also low.

Typical example, in table at right, pinpoints the problem to a plant having 5000-kw electrical load with 80% load factor. Process-steam demand is 100,000 lb per hr of 20-psig steam in summer and 130,000 lb per hr in winter. Following through assumptions and data, right, this plant comes up with a $117,000 annual savings—8.35% return on the investment.

You'll find the method illustrated a quick, easy way to see what the electrical generating possibilities are. But it has some pitfalls. Before you make a final recommendation, develop comparative annual power costs. Such a study shows up such items as: (1) possible unbalance of electrical load vs steam load (2) whether some steam must be blown to atmosphere for short-time periods (3) whether operating and maintenance costs are realistic (4) factors depending on local conditions.

Summary. Your first step is to develop load curves for all power facilities, including seasonal, daily and, in some cases, hourly load curves. Study alternate drive methods for air compressors, refrigeration machines, etc.

Contact local utilities to get existing or negotiated rate structures, available delivery voltage, and fixed charges, if any, for substations. If high reliability is of key importance, get info on utility's service record.

Keep plant design simple, economical. Consider all available fuels to get lowest possible fuel cost. Size and select equipment for minimum investment consistent with reliability and low maintenance costs.

In choosing equipment to meet plant needs be sure to take advantage of plant-production schedules, seasonal variations, and process cycles for scheduled maintenance and repair outages.

The final answer doesn't always boil down to purchased or generated electricity. For best economy you may want them to team up. Such a setup could include partial generation with or without parallel operation, utility standby, interchange of power during off-peak periods, etc. So it'll pay you to get together with utility engineers to consider every possible angle.

TYPICAL STUDY

Should this company install a power plant?

ASSUMED LOAD

Electrical-power load: 5000 kw, 80% load factor
Process-steam load: 100,000 lb per hr, 20 psig in summer
130,000 lb per hr, 20 psig in winter

FACILITIES NEEDED

With generation: 3 boilers, 60,000 lb per hr each, 600 psig, 700 F
2 turbine-generators, 5000 kw, 20-psig backpressure units
Without generation: 3 boilers, 60,000 lb per hr each, 150 psig, saturated

UNIT INVESTMENT COSTS

600-psig 700-F boilers: $10.00 per lb per hr
150 psig saturated boilers: $9.50 per lb per hr
Turbine-generators: $130.00 per kw

TOTAL INVESTMENT COSTS

With electrical generation: $3,100,000
Without electrical generation: $1,700,000
Differential: $1,400,000

PURCHASED VS SELF-GENERATED ELECTRICITY

Fig. 3, curve *c*: Purchased electricity, 9.44 mills per kwhr
Fig. 3, curve *f*: Generated electricity, 2.50 mills per kwhr for 30c-per-million-Btu fuel cost
Cost differential: 6.94 mills per kwhr to cover depreciation, taxes, investment return

DEPRECIATION

5% on $1,400,000 incremental investment. Depreciation is 1.60 mills per kwhr; 6.94 — 1.60 = 5.34 mills per kwhr remaining for taxes and return on investment

TAXES

50% tax rate; 2.67 mills per kwhr left to justify $1,400,000 incremental investment

RETURN ON INVESTMENT

With 5000-kw load of 43,800,000 kwhr yearly, potential savings are $117,000 per year, an 8.35% return

1 Aging furnaces used in studying graphitization susceptibility of the carbon-molybdenum steels for power piping

2 Creep equipment for the carefully controlled study of the creep properties of metals used in steam pipe and valves

Modern pipe materials—key to today's

Rapid advance in steam pressures and temperatures since 1945 introduced extreme service conditions for steam-pipe material. Experience with chromium-molybdenum steels, with which the steam-power industry had but little background, is summarized here to aid designers in choosing pipe for future stations

► Before 1943, when maximum temperature and pressure were nominally 950 F and 1500 psi, carbon-molybdenum steel was extensively used for main steam piping. Graphitization failure at the edge of the heat-affected zone of a welded carbon-molybdenum pipe joint, at Springdale Station of West Penn Power Co, started a major investigation of this phenomenon. It ultimately led to developing and using chromium-molybdenum steels.

Meanwhile, it was necessary to check structural conditions of similar piping systems. Based on these examinations, much of the carbon-molybdenum piping was replaced, while some was heat treated in place to restore ductility. Despite the great effort expended, a number of installations of this material are still in operation under service conditions known to cause deterioration. They are yet to be carefully checked.

Graphitization. Welded carbon-molybdenum steels, whether pipe, forging or casting, are susceptible in varying degrees to graphite formation when exposed to temperatures of 875 F and higher. Degree of susceptibility is related to aluminum content, introduced to kill or deoxidize the steel. These products are particularly suspect because killed steel is needed to produce seamless pipe satisfactorily and to insure castings free of porosity. Other deoxidizing agents offer no suitable remedy; aluminum-free steels develop graphite, but at a much slower rate. In low-aluminum steels, the distribution of graphite particles tends to be of a more embrittling character.

Graphitization assumes several different forms. One is intergramular, a chain-type formation along the edge of the heat-affected zone. It is highly embrittling because the steel develops a structure similar to gray cast iron, in a narrow area. This occurred at Springdale.

In other steels, nodules of graphite form in the same general location over a wider band, in varying concentrations. The more highly segregated produce embrittlement as severe as intergranular formations. If relatively few graphite nodules are uniformly distributed in the susceptible zone or base metal, properties of the graphitized steel are about the same as those of the unaffected material.

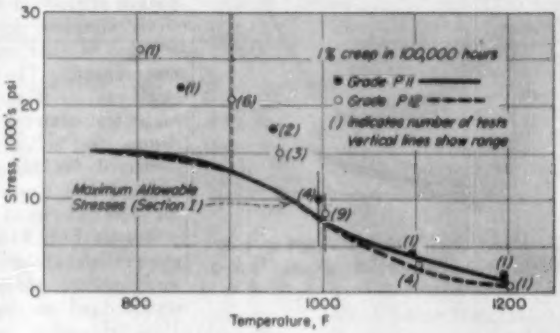
Another form, slip-plane graphitization, is found in strained areas less predictable as to location. Limited studies appear to show this type is confined to steels highly susceptible to graphite formation near welds. It may produce about the same embrittlement as chain-type formations.

Structural checks of carbon-molybdenum steel piping are best made by metallographic examination supplemented by mechanical tests. Specimens containing the most susceptible zone—edge of the weld-heat-affected area—may be removed from the pipe by a weld prober or hollow drill. Samples are compared with reference pictures issued by Edison Electric Institute for rating degree of graphitization. Repair of sampled locations is simple.

Eliminating graphitization. Attempts have been made to restore affected piping to its original ductility by solution treatment of the weld joint. Because this requires heating to about 1700 F, it may cause distortion. Where a mild degree of graphitization exists, solution of the graphite improves properties somewhat. But graphitization reoccurs

Percent composition: typical high-temperature pipe steels

	Pipe ASTM A335		Castings ASTM A217
1-1¼% chrome alloy	**Grade P11**	**Grade P12**	**Grade WC6**
Carbon	0.15 max	0.15 max	0.20 max
Manganese	0.30 to 0.60	0.30 to 0.61	0.50 to 0.80
Phosphorus	0.030 max	0.045 max	0.05 max
Sulfur	0.030 max	0.045 max	0.06 max
Silicon	0.50 to 1.00	0.50 max	0.60 max
Chromium	1.00 to 1.50	0.80 to 1.25	1.00 to 1.50
Molybdenum	0.45 to 0.66	0.45 to 0.66	0.45 to 0.65
2¼-3% chrome alloy	**Grade P21**	**Grade P22**	**Grade WC9**
Carbon	0.15 max	0.15 max	0.18 max
Manganese	0.30 to 0.60	0.30 to 0.60	0.40 to 0.70
Phosphorus	0.030 max	0.030 max	0.05 max
Sulfur	0.030 max	0.030 max	0.06 max
Silicon	0.50 max	0.50 max	0.60 max
Chromium	2.65 to 3.35	1.90 to 2.60	2.00 to 2.75
Molybdenum	0.80 to 1.06	0.87 to 1.13	0.90 to 1.20



3 Comparison of the allowable stresses with creep data for Grades P11 and P12 pipe steel at temperatures to 1200 F

better steam stations

By E A STICHA
Supervising Engineer, Crane Co

on service exposure. With severe graphitization, ductility is not restored, even though the graphite dissolves. Voids remaining in areas of previous graphite precipitation appear as detrimental to ductility as segregated graphite.

Post-weld heat-treatment studies show that though some treatments defer graphite development, none eliminate it. A possible benefit of some treatments was development of a broader graphitized zone having less deleterious effect on ductility than the segregated form.

Laboratory investigations and numerous examinations of service piping show that welded carbon-molybdenum steel construction generally should not be used above 850 F. Maximum temperature recommended for carbon steel is 750 F. Piping exposed to service temperatures above these limits is considered susceptible to graphitization and should be examined for possible embrittlement due to graphite formation.

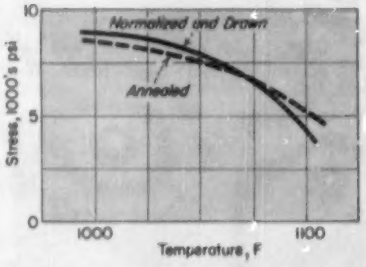
British stations experienced cracking of carbon-molybdenum steel pipe, particularly where units make frequent starts and stops. Condition is attributed to high stresses at points of stress concentration during transition periods. It is further aggravated by the relative lack of ductility of steel under these circumstances. Such failures are unknown in the U.S.

Melting-practice difference is one reason the English have no difficulty with graphitization. They use only a few ounces of aluminum for deoxidation, compared to our 1 to 2 pounds per ton of seamless-steel pipe. Remedy for each condition is the same—replacement of troublesome members with chromium-molybdenum steel parts.

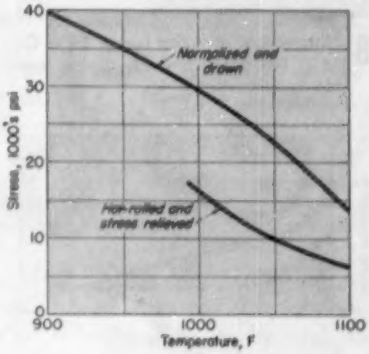
Material for temperatures above 850 F was born in research laboratories investigating alloying additions and their effect on graphitization susceptibility of carbon-molybdenum steel. Our company contributed significantly to solving this problem by comprehensive study of casting steels. Using furnaces and samples, Fig. 1, extended tests have been run on various steels for as long as six years.

Of all elements tried, chromium is the only one that offered a practical answer to providing carbide stability to welded molybdenum-bearing steels killed with aluminum. Malleable iron founders verified this to some extent. Also, similar steels used in refineries resisted corrosion of certain hot petroleum products, without graphite formation.

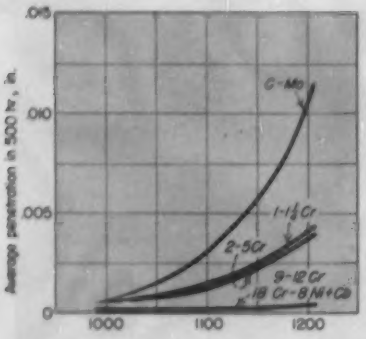
ASTM A335, Grade P2 pipe. This steel enjoyed some favor a few years ago. Nominally it contained 0.5% chromium. Equivalent casting and forging grades available were dropped from specifications. Besides chromium, the pipe-steel specification requires a coarse-grained McQuaid-Ehn grain size which, in effect, limits the aluminum addition



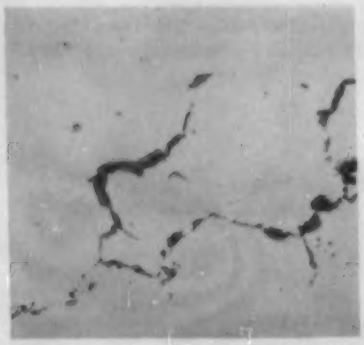
4 Effect of heat treatment on the creep strength. Note the intersection point



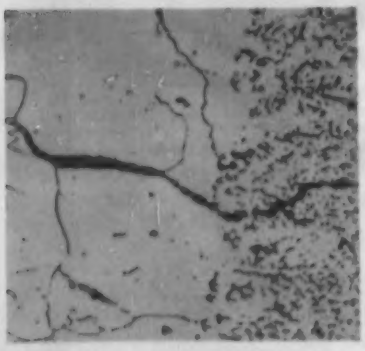
5 Improvement in creep strength of the high-temperature normalized pipe



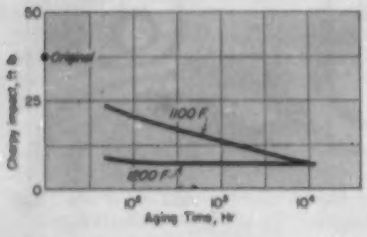
6 Effect of chromium content on pipe-steel resistance to steam scaling



7 Intergranular cracking of Type 347 austenitic steel near fusion line



8 Microcrack at fusion line of 18% Cr, 8% Ni, plus Cb weld in pipe steel



9 Effect of high-temperature aging on impact strength of a cast steel

for deoxidation and assures improved resistance to graphitization. Such restrictions are not applicable to production of casting steels where two to three pounds of aluminum are used per ton of steel. Graphite formation was found possible in some casting steels of this composition. The 0.5% chromium steel has about the same strength at high temperatures as carbon-molybdenum steel and a stronger material is preferred for higher steam temperatures. It has, however, been considered for some units up to 975 F.

Grades P11, P12, WC6. For steels more resistant to graphite formation, the steam-power industry has practically standardized on those containing 1 to 1¼% chromium for 850 to 1000 F. When it has been necessary to conserve certain critical elements, this grade has been used up to 1045 F. Greater strength is realized at elevated temperatures, permitting lighter wall pipe, fittings, etc. Some 1¼% chromium steels for high-temperature steam service give no trouble after over 10 years. It is generally used to replace severely graphitized carbon-molybdenum steels. Table, p 87, shows typical grades, under the heading of 1 to 1¼% chrome alloys.

Grades P11 and P12 are similar. Coarse-grain melting practice is used for P12; P11 has no such limitation. Use of two pipe steels so similar causes confusion. Essential difference is silicon content, though there is some disparity in chromium ranges. Maximum allowable stresses permitted these steels by ASME *Boiler and Pressure Vessel Code* are about the same to 950 F, above which P11 rates higher.

Fig. 3 shows a comparison of creep-test data for these compositions, together with *Code* stresses. Today there is hardly enough information to make a clear distinction between the two steels, particularly when differences in melting practice and heat treatment are considered. Since strength drops to a fairly low value above 1000 F, this seems to be a logical limit for 1 to 1¼% chromium-molybdenum steel.

Higher temperatures. Above 1000 F, steels of greater chromium and molybdenum contents are preferred because of superior strength and stability. Again, oil-refinery service has been helpful in selecting materials. The steel most widely used above 1000 F contains 2¼% chromium, 1% molybdenum. A similar grade with 3% chromium is used to a limited extent. Compositions of typical grades are given in the table, p 87, under the heading 2¼ to 3% chrome alloys.

At higher temperatures, increased molybdenum content gives greater strength and permits saving metal. Higher alloy content of this material requires somewhat greater fabrication and welding care, but this does not create major problems. To a lesser degree, this also applies to 1¼% chromium, ½% molybdenum steel. These materials are widely used for main steam piping to about 1060 F at pressures to about 2600 psi; performance is entirely satisfactory.

Heat treatment. What is the most desirable treatment for P22 piping steel used at 1000 to 1100 F? Carbon and low-alloy ferritic steels possess greatest creep strength when normalized and drawn. But at higher temperatures, annealed material is superior, largely because of its more stable structure. Location of the intersection point, as in Fig. 4, is important for 2¼% chromium, 1% molybdenum steel since contemplated service temperatures are close to the suspected crossover.

For over 30 years, our company has studied creep properties of metals for pipes and valves; Fig. 2 shows some equipment for this. Fig. 4 compares annealed with normalized and drawn P22 steel in two conditions of heat treatment. Intersection point is about 1075 F. Though creep resistance is not the only feature considered in evaluating high-temperature piping, other things being equal, it is a determining factor. Normalizing and drawing is the preferred heat treatment for temperatures up to 1075 F, above which annealing is used. For boiler or still tubes at higher temperatures, this steel is supplied annealed.

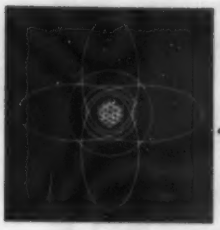
Trend to higher pressures and temperatures continues; units for somewhat above 1050 F uses 2¼% chromium, 1% molybdenum steel for main steam piping; already one unit with an austenitic-steel main steam line is operating at 1100 F and 2350 psi, while others are planned for 1200 F and 5000 psi. Some new problems had to be tackled for these conditions. For some, a solution is still wanting.

Many plants for 1000 F and higher require pipe with wall thicknesses up to 4 inches, far in excess of the capacity of existing seamless pipe mills. This was met by production of forged and bored pipe. Recent use of extrusion in pipe manufacture offers another potential supply source for heavy wall material, as do cupping and drawing.

Centrifugal casting is another possibility, and a comprehensive testing program is planned to compare this pipe with conventional materials under simulated service conditions. Substantial economy is anticipated in its use.

Heavy wall pipe presents a potential hazard because the temperature differ-

(*Continued on page* 188)



Nuclear notes

By B G A SKROTZKI, *Associate Editor*

Dual-cycle boiling reactor will be built by General Electric Co for Commonwealth Edison Co near Chicago, Ill., subject to AEC approval. Reactor sends steam to 180-mw turbine at two pressures, 600 and 350 psig. Low-pressure steam comes from flash tanks tied in circulating-water circuits hung on reactor. Heated water from reactor partly flashes into l-p steam going to turbine, remainder of water reenters reactor with incoming feedwater. Arrangement improves reactor stability in regard to load changes, preserves safety of boiling reactor.

Aqueous homogeneous power breeder reactor offered by Foster Wheeler Corp can be running by 1961. They estimate a 100-mw plant can be built for $210 per kw, produce a kwhr for 6 to 9 mills. Uranyl-sulfate solution in heavy water pumped through spherical core fissions U-235; heated solution generates 600-psi steam in four heat exchangers. Four canned rotor pumps keep solution circulating between core and heaters. Thorium-232 in heavy water circulates through vessel blanketing reactor to breed U-233 and generate about 17% of reactor total steam output in two heat exchangers. System removes fission products as they form.

'Atomic-industry growth survey, 1955-1965,' just published by Atomic Industrial Forum, Inc, 260 Madison Ave, New York 16, N. Y., sells at $7.50. Survey estimates private projects will spend less than $40 million per yr, government about $50 million per yr up to 1958. The 64-p book sees propulsion reactors (dominated by military needs for submarines and aircraft) as largest equipment market. Small reactors may be about 20-35% of propulsion-market dollar volume. Market estimates for large station reactors vary widely between maximum and minimum levels.

Reactor-core changing for liquid-cooled unit might be done as often as once a month. Present designs place core in sealed vessels to avoid radioactive leakage. They must be cut open with machine tool, refueled, then rewelded for every core change. Babcock & Wilcox Co is developing new gasketed closure for pressure vessels to cut refueling time and raise reactor load factor.

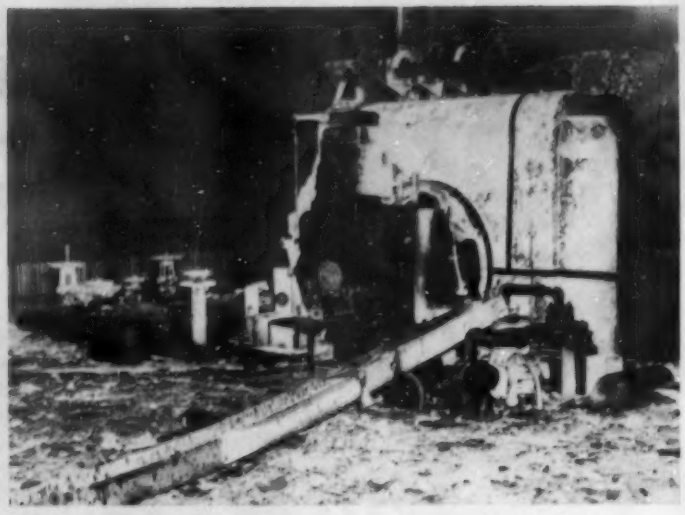
Materials test reactor of 10-mw capacity will be built by Westinghouse Electric Corp at cost of $6,500,000 without government subsidy. Light-water moderated and cooled highly-enriched reactor will be about 40 miles east of Pittsburgh, in a new "reactor center" including a laboratory for radioactive materials.

More atomic submarines will be coming—House of Representatives approved appropriations for ship-building plans including 5th, 6th and 7th U.S. Navy atomic subs. Also included were plans for five conventional diesel-powered subs.

Element 101—newest element—has been artificially created by University of California scientists under direction of G T Seaborg. Element has been named mendelevium, Mv, for Russian discoverer of periodic system of elements.

Atomic waste-disposal problem needs some radical thinking for solution. Conventional waste-handling methods won't do because of severe radioactivity of materials. One method suggests shooting wastes into space or to other planets by rocket ship. Another, destroy radioisotopes by nuclear transformation in a "waste-disposal reactor" with super-high flux. For example, when strontium-90 with 20-yr half life captures a neutron it converts to strontium-91 with 10-hr half life.

A loose bearing-thermometer...



led to this burnout—just one of...

6 ways human or mechanical failure

► IN SCANNING RECORDS of turbine-oil fires, we found that oil under pressure, contacting hot steam surfaces, caused the more serious. Since lube oil's self-ignition point is about 700 F, the fire hazard is ever present in power plants operating at steam temperatures beyond this value. Yet even though such fires can occur, records indicate the probability is slim. This in itself is a tribute to turbine designers and plant operators.

The many ways that such fires can start are pointed out in the recent fire-record bulletin *FR 55-1*, issued by the National Fire Protection Assn, 60 Batterymarch Street, Boston 10, Mass. In that bulletin you will find a summary of typical fires and their causes in electric generating plants. The following six cases outline the cause and extent of recent major plant fires. Let them serve as a reminder of the hazard present where lube oil passes close to high-temperature steam lines.

1 — Thermometer disconnected. In some unknown manner, a 1-in. thermometer-well on a turbine became unscrewed on June 22, 1951. Machine was in the Picway Generating Station near Columbus, Ohio, photos above. Lube-line pressure was about 25 psi on steam end of the 30,000-kw turbine-generator. Escaping oil was pumped out on hot turbine parts that measured between 600 and 800 F. Resulting fire drove all men from the turbine room, auxiliary operating bays and switchboard room.

Oil fire lasted between 12 and 15 minutes. It stopped when oil level in reservoir fell below pump suction. Heat was so intense it melted glass windows in main switchboard room on upper level overlooking the turbine area.

Heat also buckled several roof trusses, pulling loose the purlins in one bay. Some structural members fell to the floor along with roof sections. Station damage tallied about $475,000. When the smoke had cleared, it was found the remaining three turbines were not severely damaged. Temporary switchboard facilities were set up on the operating floor so two machines could be put back into service: first went back in seven days, second in eight. The third machine went on the line 16 days after the fire.

Turbine unit directly involved in the fire returned to service four months and 18 days after the burnout. It took about six months to restore station to normal.

2—Broken pipe fitting. Back in 1943, a 5-in. cast-iron elbow on a 40-psi lube line burst in the Hell Gate Station of Con Edison in New York City. This permitted some 1500 gallons of lube oil to pour onto a steam line just below turbine. The oil ignited at once. Fortunately, a combination of sprinklers and fire-hose line extinguished the fire. Piping and auxiliaries were damaged.

3—Oil-switch fault. On March 2, 1953 an oil-immersed disconnect switch overtraveled and grounded on tank bottom at Chats Falls, a hydroelectric station in Ontario, Canada. Since switch blades were live, resulting arc burned through the switch tank igniting the switch oil. Fire quickly spread to other oil or compound-filled equipment.

Switch gallery is 15 feet above generator floor and 21 feet below the unprotected steel-frame roof. Fire burned about an hour before outside fire-fighters arrived.

Early fire damage was confined to the switch gallery and roof. However, a section of roof collapsed and broke the governor of a 23,500-kva vertical generator. Oil gushing from the governor poured into the turbine pit and ignited. Hot gases were drawn through generator fans burning out stator windings.

4 — Mechanical vibration. Trouble descended once again on Con Edison's Hell Gate Station when a 65,000-kw generator developed a serious vibration on March 19, 1952. Resulting movement caused gas seal on generator bearing to open, allowing hydrogen gas to enter oil line returning to reservoir.

Are fire-resistant turbine lubricants the answer?

Probably so, when the bugs are ironed out. As reported in POWER, March 1955, p 75, there are several problems yet to be solved before such fluids can be adopted. One of the biggest headaches right now is the harmful effect they have on generator insulation. Based on the limited data available at this time, the lubricating ability of the phosphate ester or hydrolube materials does not appear to pose a problem.

Today's fluids in the fire-resistant category, slated for possible use in steam turbines, lean heavily for their technical support on the background work done in industrial and aircraft hydraulics. There the fire problem was wrestled with for years, and several materials have evolved that are doing a topnotch job. It's tough to predict what tomorrow holds for these proposed turbine fluids: Much depends on current lab tests being made by turbine builders and later field checks.

By JOSEPH J SHOEMAKER, *Consulting Engineer, Pleasant Ridge, Michigan*

has caused major turbine-oil fires

Bearing was hot enough to ignite the hydrogen gas. Flame traveled down the main oil line to reservoir, causing an explosion. This explosion burst the reservoir, blowing open an access plate so all oil in system, about 3000 gallons, ran out on the basement floor. Oil was thrown onto a steam pump, igniting the heat insulation. Fortunately fire was put out by plant operators before it ignited oil on basement floor.

5—Sudden stop. At 6:14 am on April 1, 1954, a mechanical failure occurred on a 100,000-kw generator in the Richard L Hearn Station at Toronto, Canada. Trouble caused the generator to come to a fast stop. In so doing the turbine coupling was sheared, bearing pedestals shattered, foundation bolts and pipe connections to lube oil and hydrogen cooling system broke off. Fire flared at the generator end. Turbine was shut down immediately and came to rest in about 30 minutes but not before pumping 3000 gallons of lube oil into the fire. It burned for about 45 minutes.

Plant men fought the fire with four 2½-in. solid-stream water lines supplied by an emergency gasoline engine-driven pump. Fire was held to area under the generator. Yet heat was great enough to start a roof fire after flying parts had cut two large holes in the roof. The 150-ton turbine crane was close to generator when fire started. Heat destroyed crane motors and their controls. Loss of this crane seriously hampered cleanup work after the fire. Although entire station was shut down when fire started, one unit was back in service at 11 am that same morning.

Only four days later at 11 am a similar mechanical failure occurred on Unit 2, causing the 100,000-kw turbine-generator to come to a noisy stop in about 18 minutes, without shearing the coupling. Fire started under the generator and between 1500 and 1700 gal of lube oil were pumped into the fire. Complete station was shut down immediately and water sprays below No. 2 turbine and over the oil reservoir were turned on.

Six solid 2½-in. hose lines were played on the fire from upper and lower levels. Water fog proved ineffective because of difficulty in getting close to fire. Once again the emergency engine-driven pump supplied water. Within five minutes after the fire started, you could not see or breathe in its vicinity. Within eight minutes the entire turbine room was filled with dense smoke. City firefighters brought in a powerful portable searchlight supplied from their own gasoline-engine generator. Gas masks and searchlights are a must in fighting this type plant fire.

6—A 5-minute stop. When mechanical trouble shut down a 90,000-kw unit of an Indiana utility in Jan 1953, the turbine rolled to a stop in less than five minutes. It stopped so fast that foundation bolts and oil lines were broken. When lube oil spewed over the 1000-F steam lines a fire started. Since machine made a quick stop, oil pumping was limited to about 1800 gal. Although entire plant was shut down, fire burned for about 1½ hours until all oil was consumed. Water had to be relayed 4280 ft from a public hydrant since there was no power supply available for plant pumps feeding the yard hydrants.

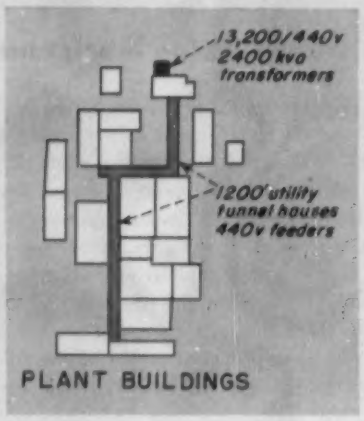
Main fire damage was in auxiliary electrical gear, motors, wiring. Thousands of feet of light, power and control wiring were destroyed. Loss was estimated at about $350,000.

What to do? The above examples point up the importance of (1) studying the possibility of using a suitable fire-resistant turbine fluid (POWER, March 1955, p 75) (2) providing for topnotch firefighting equipment plus an adequate emergency water supply (3) checking adequacy of present and planned means for storing flammable fluids and gases (4) developing a training program for controlling and extinguishing power-plant fires.

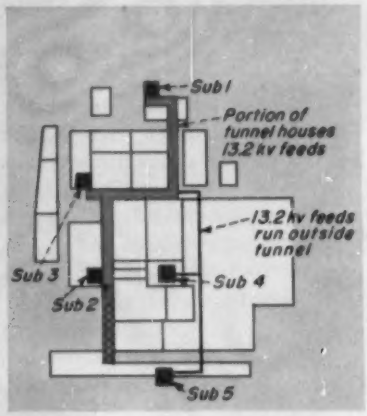
Inadequate IC prompted new 13.2-kv scheme

When two Philadelphia plants were combined on 37 acres, peak electrical-demand load rose from 2000 to 5000 kw.

Here's how new system is laid out, making full use of existing equipment



1950 Load is fed from single transformer bank through 440-v lines



1955 Five secondary substations needed to handle 5000-kw load

Exide plant swings to 13.2 kv, 5 power

► ELECTRICAL-LOAD UPSWING, after welding two plants into one, could not be handled by simply expanding the distribution system in original Crescentville (Philadelphia) plant of The Electric Storage Battery Co. The outmoded electrical-power distribution system consisted of two 1200-kva banks of oil-filled 13,220/440-v transformers spotted at plant's far end. They fed a widely distributed load at 440 v through eleven 600,000-cm secondary feeder-cables.

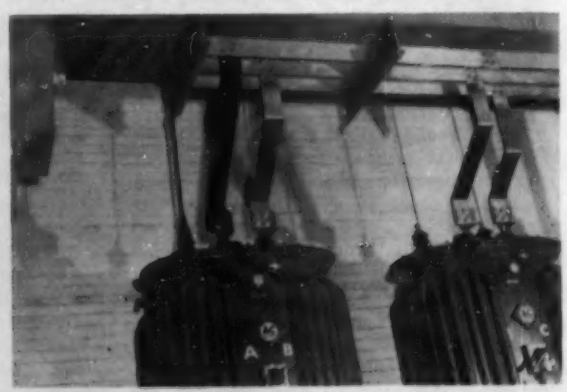
New loads could not be managed simply by adapting old low-voltage system since: (1) Interrupting capacity of existing 13.2-kv breakers was 65,000 kva at best, whereas 150,000 kva capacity was needed. (2) Secondary feeders at 440 v stretched anywhere from 300 to 1200 ft. (3) Insulation on many secondary cables was poor after some 30 years' operating in a service tunnel along with steam mains feeding plant.

After study, a load-centered simple-radial primary 13.2-kv system was adopted. In contrast to the trend toward dry-type transformers, we found oil-filled transformers in vaults best fitted our needs. Oil-filled units were practical since one bank of oil transformers was already on hand and building plans were such that little construction was required to build in the new vaults.

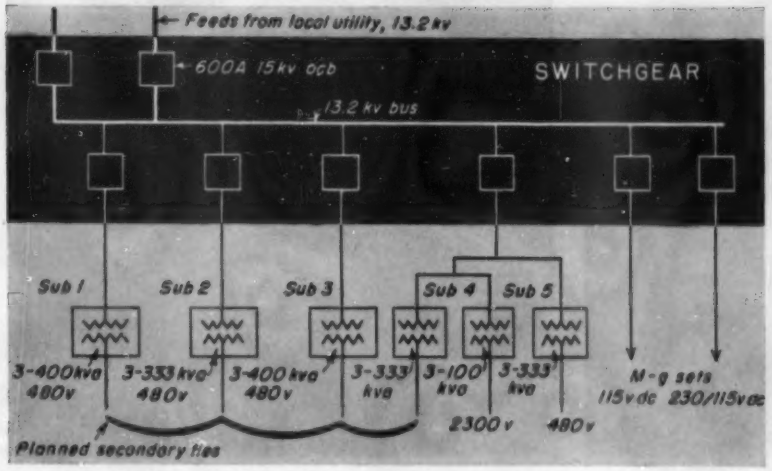
By J M COUSLEY, *Electrical Engineer, The Electric Storage Battery Company*

New switchgear and load-center transformers lie at end of 13.2-kv

NEW SWITCHGEAR at load centers handles 440-v distribution and circuit protection. Note contrast to old open-front gear



LOAD-CENTER TRANSFORMERS in vaults close to secondary switchgear. Single-phase units grouped for 3-phase operation



PLANNED SECONDARY TIES will use old low-voltage cables in utility tunnel. M-g sets here are really 230/115-v balancer sets supplying power for battery forming

centers for 5000-kw load

Using new oil transformers in the same sizes as existing units (333 and 400 kva) gave us an interchangeability advantage for possible emergency operation. Finally, we have been using oil-filled transformers in the plant for some 30 years without service interruption—an excellent recommendation in itself.

Utility tunnel running through the plant formed a ready-made cable tunnel for our new primary-distribution system. We ran most of the 13.2-kv primary lines through this tunnel using lead and neoprene cable. Note from sketch, facing page, utility tunnel served as a housing for some feeders over a portion of their run. Abandoned secondary cables were left in tunnel with the thought of repairing them before using as secondary ties in an emergency.

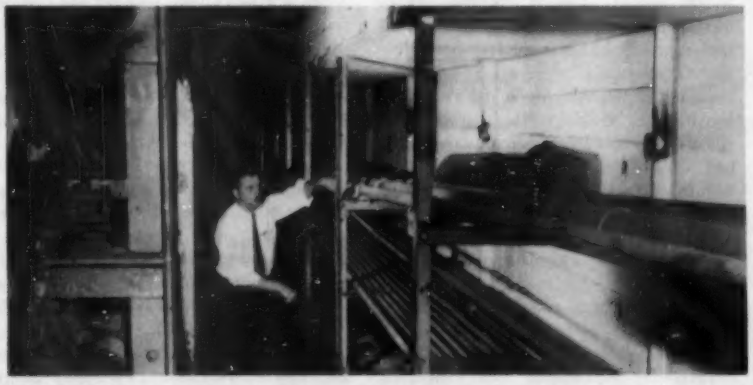
Dc load is a sizable matter since we're in the battery manufacturing business. Original plant distributed 2500 kw at 250-v dc for battery forming and charging. Feeding new battery-forming circuits boiled down to determining most economical way of using present 2500-kw capacity to supply 230/115 v on a 3-wire system. At first blush it was felt the best way might require converting existing generators to 3-wire 230/115 v. Cost study proved this uneconomical. Another thought was to connect the forming equipment in series and use 230 v. However, an analysis of production needs showed this setup not too feasible. The economical answer proved to be balancer sets.

Balancer sets were installed close to the forming rooms. Short distance meant length of the ¼x4-in. 1000-amp neutral copper was held to a minimum. Forming circuits were fitted with DPDT switches to place loads on either positive or negative side of set, keeping neutral unbalance within the 1000-amp figure.

Since buying the first balancer set, a second set has been installed and connected in parallel. This provides some capacity if one set is down for maintenance or repair. At same time, second set increased unbalanced-neutral capacity to 2000 amp, meaning higher forming rates were now practical.

Engineering study for complete electrical installation was made in conjunction with Chas E Tull Co, electrical contractors, and Ballinger Co, architects and engineers. Total job involved changes to existing buildings, engineered by The Electric Storage Battery Co, and addition of new buildings designed by the architect. The same electrical contractor handled the work on both electrical installations.

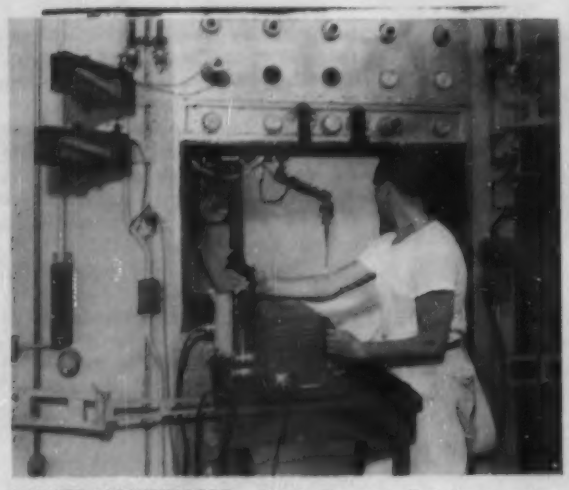
feeders carried through old utility tunnel



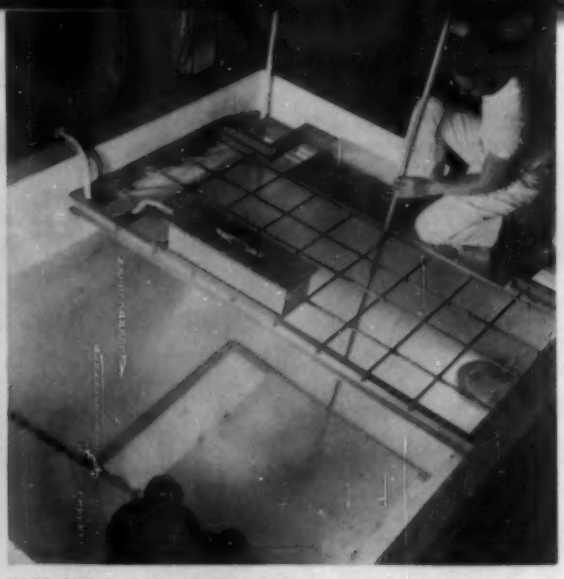
PLANT UTILITY TUNNEL houses plant services including 13.3-kv primary distribution feeders. Author is seen alongside new conduit-enclosed lead and neoprene cables

EDITOR'S NOTE: *Although oil-filled transformers account for the biggest kva volume manufactured today, they are more generally limited in industrial-plant applications to outdoor primary substations. Indoors, a fireproof vault is needed. Askarel, a nonflammable liquid, sidesteps oil's fire hazard yet retains high-impulse level* (POWER, Oct 1953, p 96-97).

Dry-type transformers are getting a big bid. They eliminate maintenance of liquids, yet not without presenting new problems of their own. In the dry-type ventilated designs, dirt accumulates within housing so side plates must be removed occasionally and unit blown out. Dry-type sealed transformer trims maintenance problems to the bone. Although it's premium priced (about 50% above cost of oil-filled in many sizes) it offers absolute sealing with inert gas at slight positive pressure.



REMOTE MANIPULATOR, electrically controlled by operator, handles item in hot cell after removal from the atomic reactor



3000-CURIE COBALT-60 SOURCE in water-filled pit irradiates the metallic and nonmetallic materials undergoing study

Atomic radiations change materials

Design engineers planning nuclear reactors must deal with radiations as an additional factor to the more usual weight, strength, hardness, thermal conductivity, electrical resistivity, etc, considered in many machinery arrangements

By
C MANNAL, *Reactor Engineering Section*
C A BRUCH, *Metallurgy Section*
R F KOENIG, *Materials Engineering Section, Knolls Atomic Power Laboratory (Operated for AEC by General Electric Co)*

► RADIATIONS produced by nuclear reactors are the same as those physicists have handled for many years. These include: (1) *gamma or X rays*—electromagnetic waves similar to light waves but much shorter and more penetrating (2) *beta particles*—electrons accelerated to high speeds (3) *alpha particles*—nuclei of helium atoms accelerated to high speeds (4) *protons*—nuclei of hydrogen atoms (5) *neutrons*—particles almost equal in mass to hydrogen-atom nuclei but carrying no electrical charge. In addition to these, there are electrically charged individual atoms of any element (ions) accelerated to hit a target.

Before discovery of atomic energy, a few laboratories produced these particles in small numbers under special conditions. Now atomic-energy processes produce them in enormous numbers.

All these particles may be measured as the number passing through a given unit area per second with a given average energy per particle. We consider electromagnetic waves either as particles (photons) or as wave fronts. Antedating the quantum theory, the units for X and gamma rays are in terms of an energy absorption per unit of material of density 1; the unit is the roentgen (r). One r corresponds to absorption of 93 ergs in 1 cu cm of water, which has the relative base density of unity.

Instruments with a wide range of sensitivities measure these radiations simply and directly. When planning to use known concentrations of radioactive materials the radiation levels can be accurately predicted. Attenuating or reducing radiation by distance or shielding has become a fairly well established art.

We often have requests for equipment designs "to withstand radiation." This has no more significance than a request for equipment "to withstand voltage" or "temperature." An economical design cannot be made unless an upper voltage or temperature is specified. The same holds for radiation.

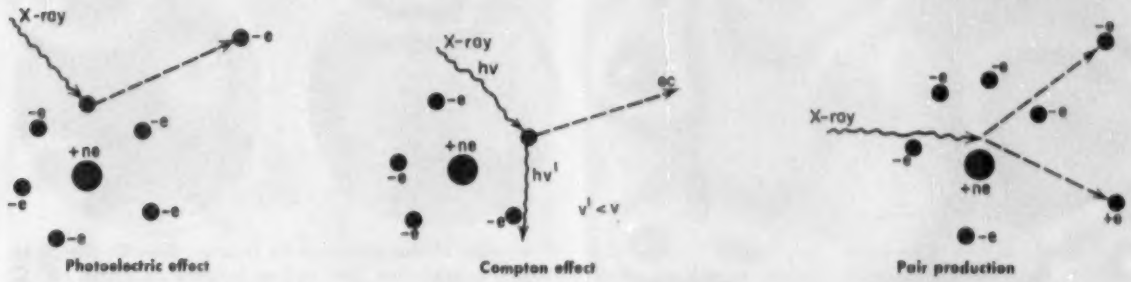
How radiations affect matter

Electrons. When a high-speed electron passes through solid or liquid matter, its force field interacts with the force fields of electrons near the various nuclei of the solid or liquid. This ejects electrons from the atoms, leaving them in an electron-deficient or ionized state. The original electron projectile proceeds with its energy reduced by the amount lost in the interaction. There are many such interactions in 1/1000th of an inch. The table gives representative ranges for electrons, protons and alpha particles in various materials.

X and gamma rays can take part in three basic processes: (1) photoelectric ejection (2) Compton effect (3) pair production, see Fig. 1.

In the photoelectric effect a photon interacts with an atom to transfer all its energy to an electron, ejecting the electron from the atom. In the Compton

Effects of X rays and gamma rays on atoms



1 X rays and gamma rays entering atoms can produce any of these three effects depending on the energy they carry and how close they approach the nucleus. Photoelectric effect needs the least energy of the three, pair production the most

Range of particle travel in materials

Particle	Particle energy	Distance of particle travel—cm				
		Air	H_2O	Al	Fe	Pb
Electrons	100 ev	0*	0*	0*	0*	0*
	10 kev	0.17	0.00022	0.00008	0.000028	0.000039
	100 kev	12	0.015	0.0056	0.0019	0.0026
	1 mev	310	0.4	0.15	0.051	0.07
Protons	100 kev	0.14	0.0001*	0.0001–	0.0001–	0.0001–
	1 mev	2.3	0.0015*	0.0013	0.00044	0.00055
	10 mev	115	0.1*	0.062	0.025	0.026
Alphas	100 kev	0.1	0*	0*	0	0
	1 mev	0.56	0.0004*	0.0003	0.0001–	0.00017
	10 mev	10.5	0.01*	0.006	0.0022	0.0026

*Approximately

effect the ejected electron takes on only part of the incident X- or gamma-ray energy. In pair production, the gamma ray in the presence of the rapidly changing force field of a nucleus suddenly disappears and two particles, a positive and negative electron, are created. Creating this amount of mass requires about one million electron volts (mev) of energy.

Each of the above processes is important in a different energy region: photoelectric effect predominates at about 50,000 ev, Compton effect around 500,000 ev and pair production cannot occur below 1 mev and is significant only above 5 mev. Once the initial photon creates one or several secondary electrons, the basic processes are exactly as described under electrons.

Alpha particles and protons collide with the nuclei of atoms. Protons are about 2000 times and alpha particles about 8000 times more massive than electrons. These particles can lose energy by direct contact with atomic nuclei. When the particles have enough energy they can knock atoms from the sites they normally occupy in a solid.

Neutrons being uncharged electrically are not affected by electron fields of atoms. They interact only with other nuclei and may travel much longer distances before being swallowed by a nucleus. If a neutron has high energy it can also knock atoms from their sites in a solid structure by a head-on elastic collision. It takes only about 25 ev to move an atom from its position in a crystal lattice and neutrons may have from several hundred thousand to several million or more ev. So a single fast neutron can cause many dislocations.

Similar to a gas molecule, the neutron can have an average energy fixed by temperature of the atoms with which it collides. So-called "thermal" neutrons, corresponding to room temperature, have an energy of about 0.025 ev. Fast neutrons may have energies from several ev to several mev. Since fast neutrons cause most damage, results must be interpreted both on neutron flux and neutron energy.

Radiation on nonmetals

With few exceptions, irradiation deteriorates the properties of materials. Ionization of individual atoms is similar to the effects produced by intense local heating. In a few special instances uncured or unpolymerized materials can be cured or polymerized by radiations.

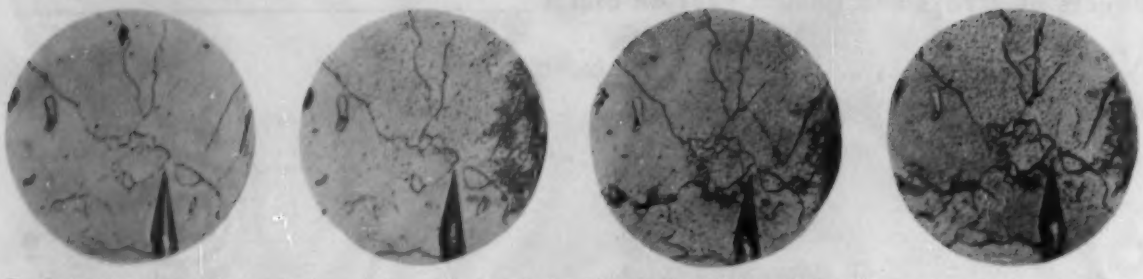
Generalizations based on a wide variety of separate processes must be used cautiously. The following comments are general guides and not absolute conclusions:

1. In general, most common organic materials will withstand about 10^6 r of X or gamma irradiation, or an integrated dose of 10^{15} thermal neutrons per sq cm without drastic change in properties.

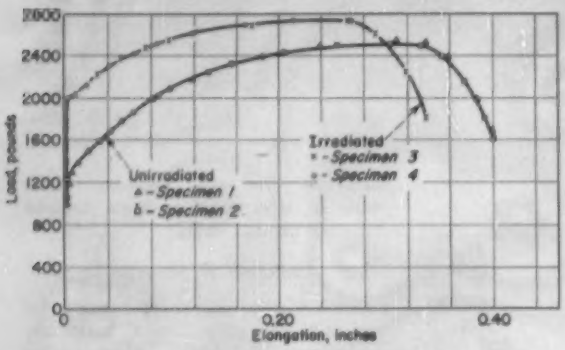
2. Organic liquids usually thicken. When used as lubricants care must be taken that solidification doesn't raise a disassembly problem.

3. Organic materials may give as much as 100 cc of gas per gram of material irradiated at levels of 10^{18} neutrons per sq cm. This may be from gases dissolved in the structure during manufacture or from deterioration of the material into gaseous components. This varies widely, depending on the specific material and its history. Place gas-generating material cautiously; in hermetically sealed containers, pressure buildup may rupture container.

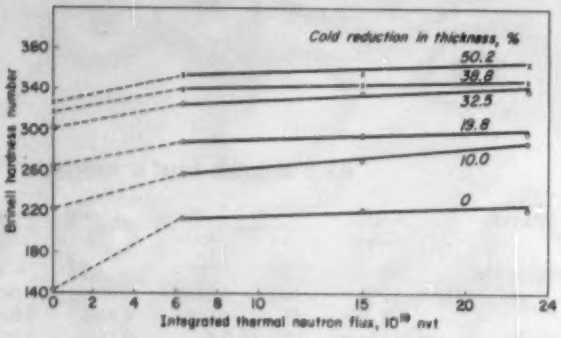
4. Plastics containing ring-type molecular structures seem to be more radiation resistant. Phenolformaldehyde resins (bakelite), carbozol, duralon, polecton, etc, are among the best organics. Their properties are greatly improved by adding inorganic fillers



2 Photomicrographs of arc-melted molybdenum, *l* to *r*, etched prior to irradiation, after irradiation, etched additional 30 seconds, etched additional 60 seconds, show no change in micro structure when irradiated at temperature under 100 C



3 Stress-strain curves of irradiated and unirradiated specimens of stainless steel show strength and ductility change



4 Radiation of 347 stainless steel increases Brinell hardness for all degrees of cold reduction of steel thickness

such as talc, mica flake, magnesium oxide, etc.

5. Cellulose and cellulosic derivatives (paper, cloth, etc) deteriorate rapidly and should be avoided. This also holds for materials based on cellulose.

6. Most inorganic materials offer excellent resistance to irradiation. Glass, mica, alumina and similar refractories change very little from radiation doses of 10^{10} r and 10^{10} thermal neutrons per sq cm.

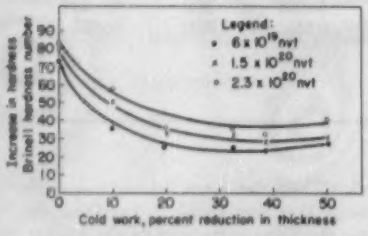
7. Organic materials of straight molecular chain varieties, such as paraffin, polyethylene, etc, are fairly good under irradiation with a few notable exceptions. Teflon, fluorothene, lucite, ethocel and Kel F are extremely poor and deteriorate under very low radiation dosages.

8. Chlorine - containing polymers (polyvinyl chloride, Saran, vinylite) are much poorer than the bakelite group but could be used for some applications at lower range of radiations.

9. Silicone resins are in general very good in withstanding radiation.

Structural-metal radiation

Reactor radiations have three main effects on metals: (1) heat generation (2) atomic transmutations (3) atomic displacements. *All* reactor radiations generate varying amounts of heat in metal, but only neutrons produce atomic transmutations. High-energy neutrons, heavily charged particles and fission fragments produce the atomic displacements.



5 Effect of pre-irradiation cold work on the irradiation-induced hardness

Heat generated by radiation depends primarily on gamma rays. Metal temperature rise depends on the flux and energy of the rays and the rate of heat removal. High temperature, because of deficient heat removal, may cause metallurgical changes, such as precipitation of a new phase of recrystallization, resulting in changes in properties of the metal.

Atomic transmutations, caused primarily by thermal neutron capture, change a metal into an alloy having various amounts and kinds of solute atoms. Such an alloy becomes complex because all the impurities also undergo transmutation. The solute atoms have some effect on the metal properties depending on their kind, abundance and dispersion in the metal.

The number of new isotope atoms formed by thermal neutron capture can be figured by:

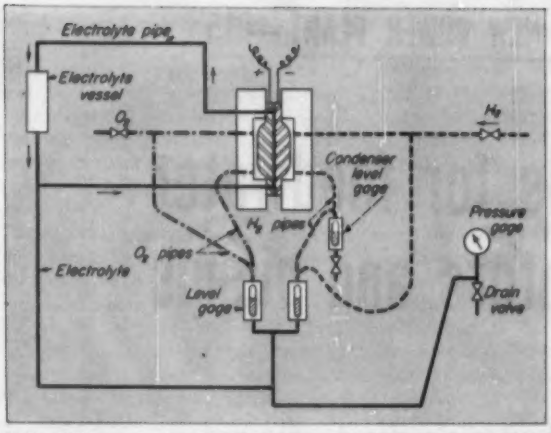
$$N = N_o s n v t$$

where

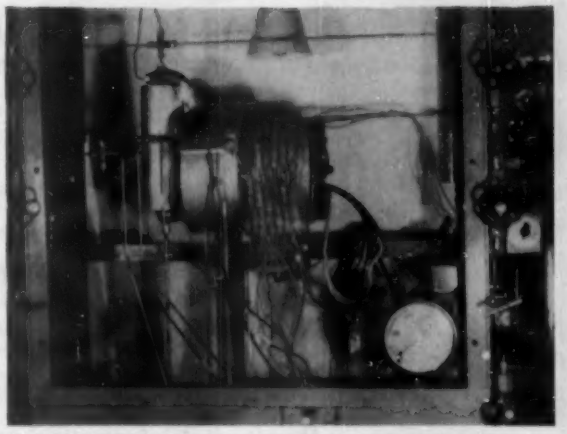
N = number of daughter isotope atoms
N_o = number of parent isotope atoms
s = thermal neutron capture cross section in sq cm per atom
nv = thermal neutron flux in neutrons per sq cm per sec
t = time in seconds

Values of s for various isotopes can be found in references [1, 2] at the end of this article. With these and known values of flux, the fraction of solute atoms can be calculated for various exposures. (Higher-energy neutrons make a small additional contribution to the transmutation process.) Making such a series of calculations we can find the length of time needed with a given thermal-neutron flux to form 1% of an isotope from a parent isotope having a neutron capture cross section of 1 barn

(*Continued on page* 196)



FUEL CELL uses pressurized oxygen and hydrogen, potassium hydroxide solution electrolyte and porous nickel electrodes



O-H FUEL CELLS, six in number, are arranged in series to produce 4.8 v, about 25 amp. Electrodes have 5-in. diameter

Sizable power output from fuel cells–soon?

Fuel cells produce electricity by combining hydrogen and oxygen to give water. Not a new idea, but only recently has there been any prospect of getting a practical unit

► LONDON (*McGraw-Hill World News*): Fuel-cell research has shown promising results at Cambridge University. F T Bacon, leading the project at the University's Department of Chemical Engineering, has set up a successful laboratory working model, which has run over 1000 hours. He is now making plans for a prototype fuel cell with an 8-kw output.

Description. Laboratory unit mentioned above was designed by Bacon and T M Fry. Schematic of single cell and photo of a 6-cell laboratory unit are shown above. Referring to schematic, single cell of laboratory rig consists of (a) two circular outer plates of steel with nickel-plated inner surfaces (b) two circular porous-nickel electrodes centered between outer plates (c) standard high-pressure steam joints, which are also used to insulate between the electrodes. Insulated bolts hold the cell together.

Internal diameter of the cell is five inches. Electrodes are 5/32 inches thick and have 1/16-inch space between them; 27% potassium hydroxide electrolyte solution circulates in the 1/16-inch gap between electrodes. Gases circulate between electrodes and outer plates—oxygen on the positive side, hydrogen on the negative. Nickel coating on the electrolyte side of the electrodes has smaller pores than rest of nickel electrode.

Operation. Cell operates at temperatures from 284 to 464 F and at pressures from 600 to 800 psi. Constant positive pressure of 1.5 psi in gas chambers keeps electrolyte from entering electrodes any further than small-pore nickel coating, but is not high enough to allow gas to force its way through the coating to the electrolyte. Essential reaction takes place along thin surface where gas and electrolyte are just in contact.

Pressure differential is maintained by readings from two Klinger water-level gages. A thermal siphon circulates the electrolyte. Electric-coil heaters keep cell at constant temperature—for units over 2 kw, reaction gives off enough heat so outside heating would be necessary only for very light loads.

Performance. Bacon's laboratory model has now run over 1000 hours—one third of the time on load and the rest on open circuit at operating temperature. Maximum theoretical voltage possible from cell is 1.2 (based on free energy of reaction). Laboratory cell produces 90% of this maximum on open circuit, efficiency drops to 50% under severe overloads. But overload appears to have no bad effects on cell life.

Bacon found that running cell at 392 F, a current density of about 0.2 amp per sq cm and a voltage of 0.8 (65% efficiency) gave best conditions for long life. So for a single 5-inch diameter cell, this would mean a current of 25 amp, or a power output of 20 watts. Photo above shows six cells in series giving 4.8 volts. Larger numbers in series and larger-diameter cells pose no particular design problem. Electrodes of laboratory unit have shown no signs of deterioration.

How it works. Thin layer of nickel oxide quickly forms on oxygen electrode on initial operation. This absorbs and activates molecular oxygen which combines with water present in electrolyte to form OH^- ions. Electrons for this reaction come from oxygen electrode. Hydroxyl ions then travel through electrolyte to negative electrode where they combine with molecular hydrogen absorbed there, giving up electrons to hydrogen electrode. This sets up the electromotive force between the electrodes, and equalization of potential difference occurs as electron flow via the external circuit.

HOW TO ORGANIZE YOUR NEW POWER PLANT — 15

Operating details for feedwater heaters, deaerators and pumps

Here's vital information on how to run closed, open and deaerating heaters, plus boiler feed pumps. Included also are remedies to cure some common operating troubles

By D C SWIFT, *Ebasco Services Incorporated*

► SUPPLEMENTING the information given in April, p 118, and February, p 104, here are further pointers on operating and trouble shooting.

Closed feedwater heaters are frequently used between feed-pump discharge and the boiler. They raise feedwater temperature closer to boiling temperature in the boiler, using heat in steam bled from a turbine after partial expansion. This heat is saved instead of being wasted to the condenser and generation cycle efficiency is improved.

Ordinarily there is a bypass around the heater with stop valves on each side of it. Bypass valve should normally be open with at least one stop valve closed. To cut a heater into service: (1) Open both stop valves gradually. (2) Then gradually close bypass valve so full flow from boiler feed pump passes through the heater. Heater will be warmed to the temperature of the feedwater. (3) When bled-steam pressure is high enough so corresponding saturation temperature is a few degrees above feedwater temperature, slowly turn steam into the heater.

Steam line must be completely drained and carefully warmed up to avoid water hammer in the piping. If steam pressure is below atmospheric, drains must return to the condenser or some other point of low pressure. Otherwise, air is pulled back into the turbine.

Open vents to some point of lower pressure to remove air or other noncondensable gases in the heater. Steam condensate must be removed continuously to keep heating surfaces clear for further condensation.

Condensate may be (1) returned to a drip pump that delivers it into the feed line or (2) discharged through a flow-control valve into a lower-pressure heater. Under certain load conditions you may not have enough pressure difference to force the condensate into the lower-pressure heater. Unless you provide an alternate drain to a still-lower-pressure point, the heater may become temporarily flooded, and you will get little or no temperature rise in the feedwater.

As turbine load picks up and pressure difference between bleed points increases, heaters usually clear themselves. But this may happen rapidly, resulting in (1) fast temperature changes in feedwater heaters and piping, and (2) hammering in the drip piping. Best system: Keep the heaters drained at all times, if possible.

With suitable draining and venting, you can leave closed feedwater heaters in service through a turbine shutdown and startup. This requires minimum operating attention, and gives gradual temperature changes, corresponding to turbine load changes. Open vents wide, letting them discharge through a $\frac{1}{8}$- to $\frac{3}{8}$-in.-diameter orifice during startup and load pickup. After you reach a steady load condition with steam pressure above atmospheric, close the vents and leave them closed.

Drains may have to be diverted to a low-pressure point temporarily before shutdown, and left there until load increases enough so the normal drainage route is satisfactory.

Heater performance. Closed feedwater heaters are designed for a standard heat-transfer rate per square foot of heating surface per degree of temperature difference. This is generally expressed as a certain number of degrees terminal difference at full load. Difference between saturated temperature corresponding to steam pressure at heater inlet and temperature of feedwater leaving the heater affords a convenient expression of performance.

But heater design and steam conditions may affect the absolute design value. For instance, units using bleed steam with several hundred degrees of superheat often incorporate a desuperheating section that heats the water on its last pass through the heater. This may raise leaving feedwater temperature above saturation-steam temperature.

Check whether performance meets the guarantee as soon as possible after putting the new plant into operation. When unit is running, check periodically to see that performance remains within a degree or two of the original.

If performance isn't up to standard, check for (1) dirty tubes (2) improper or insufficient venting (3) water short circuiting across dividing baffles (4) excessive pressure drop in steam passages (5) flooding of heat-transfer surfaces.

Tubes usually get dirty on the water side. Clean by circulating chemical solutions through them, or by using mechanical cleaning devices. Obtain samples of the deposit and have them analyzed. Then you can determine the best cleaning solution to use. Be sure fresh cleaner reaches all surfaces, and use proper neutralizer afterwards.

Heater troubles. Leaks are a big cause of trouble. When you put new heaters into service, or start a unit after removing a head for inspection or cleaning, retighten joint bolts when heater reaches normal temperature. This helps insure against joint leakage. Other causes of joint leaks include cold drafts and sudden temperature changes.

Stop leaks promptly to avoid water cutting the joint faces. Insulating joint bolts may help prevent strains by protecting against cold drafts and reducing heat loss. But if the strains come from internal temperature changes, insulating the joints may cause more leaks. Bolting will not follow temperature decreases rapidly since heat loss is reduced. If you apply insulation, use removable units for economical inspection and repair.

You can spot a leaky or split closed-heater tube by the increased quantity of condensate. This may cause an unusually high water level in the drip pot. If leak is not large enough to affect drip-pot level much, you may have to shut off steam drip and vent lines to and from heater. Observe heater level with feedwater passing through it to determine extent of leakage. Repair leaks promptly to avoid cutting heater tube sheets seriously.

Plug split tubes with tapered metal plugs on each end until so many have failed that you get high water-pressure drop or poor heat transfer. Then shut down for repairs.

Leaky internal gaskets sometimes let water bypass part of the heater's surface. About the only way to spot this trouble is to inspect joint surfaces and their imprint on the gaskets.

It's important to have clean, smooth, true joint surfaces, and to use a gasket material that will not deteriorate under the service conditions. Some engineers prefer a resilient gasket, while others favor the solid-metal type.

Low-pressure closed feedwater heaters that heat condensate between condenser and feed-pump suction are similar to the high-pressure units discussed above. Since they operate at lower temperatures and pressures there is less trouble with joint leakage. But iron-oxide deposits seem to develop more rapidly on the low-pressure tubes.

If steam pressure is normally below atmospheric, you have to vent continuously through ¼- to ⅜-in. orifices. Drainage may be more troublesome because of lower pressure differences between heaters. Ordinarily a drip pump moves condensate from the lowest-pressure heater back into the condensate line. The pump suction should connect to a liberally sized drip tank. This prevents rapid surges and irregular action of the pump-discharge regulator that controls drip-tank level.

Suction pressure may be considerably below atmospheric. Be sure that drip-pump glands are sealed and that the pump vents back to the drip tank or the condenser to protect against air or steam binding.

Steam lines from turbine to low-pressure heaters may become waterbound. To prevent this, drain all low points in the piping with amply sized traps discharging back to the condenser.

Provide high-water alarms on all closed heaters. Otherwise, improper drainage might cause heater to flood completely and let water drain back to the turbine.

In higher-pressure heaters, a check valve generally prevents back flow. But low-pressure bleed-steam lines are bigger. A check valve may be too cumbersome and cause a relatively large pressure drop. You can substitute a motor-operated gate valve, controlled to close if heater level becomes too high.

Some low-pressure heaters are in the neck of the condenser with no steam line stop or nonreturn valve provided. But they have a drip pump and a return line to the condenser large enough to handle the excess water should a tube fail. High-water alarms are also provided, to warn of need for bypassing heater, cutting it out of service if drip-disposal units cannot handle the water.

Open heaters provide for direct contact between the water being heated and the steam doing the heating. They are ordinarily used under low pressures, 50 or 60 psi top. These units have little terminal difference if entering water sprays or passes over trays so the steam has a large condensing area to work on Water level in the heater must regulate entering water; otherwise, a pump must remove water and condensed steam as fast as they come in.

Units need high- and low-water alarms and an emergency overflow to prevent forcing water into the steam-supply line. Check the alarms and try out the overflow valve periodically. Also, see that water-level or steam-pressure regulating valves work freely without excess play.

A loop seal may be used on the overflow. If steam pressure rises high enough to blow out the seal you will have to drop pressure before re-establishing the seal. A water filling connection on this seal is quite helpful.

In a series of low-pressure open heaters, a multiple-section condensate pump is sometimes used. Water from each heater returns to the suction of the next-higher-pressure section of the pump. In this case, you don't need regulating valves. Water moves from one section to another as fast as it is pumped from the condenser hotwell.

Water not required by the feed pumps goes to storage tanks. If hotwell level falls, storage-tank water makes up the amount required by the pumps.

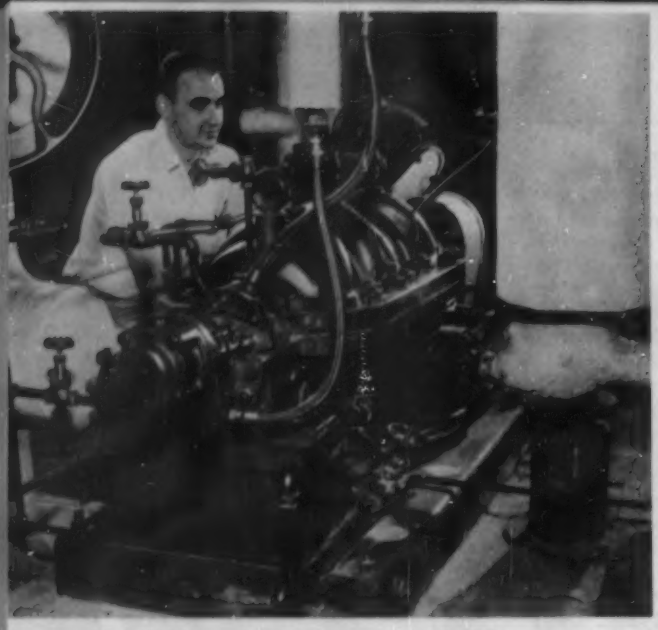
Deaerating heaters are designed to remove dissolved oxygen from boiler feedwater. Sometimes deaeration is accomplished in special-design condenser hotwells where condensate is reheated to steam temperature and the released gas is removed. But deaeration is theoretically more complete at temperatures higher than usually found in a condenser. Hence, special deaerating heaters are frequently used. They are often placed so boiler feed-pump suction is taken from the heater storage tank. Steam from a turbine-stage bleed, exhaust from auxiliaries or vapor from an evaporator may supply the heat.

Here's how they usually work: Cool incoming water passes through a tubular vent condenser. Steam and gas released from the water being deaerated also go through the condenser. Most of the steam condenses on contact with the cool tubes, and the noncondensable gas escapes through the vent. Little heat is lost, since most of it is absorbed in the water passing through the condenser.

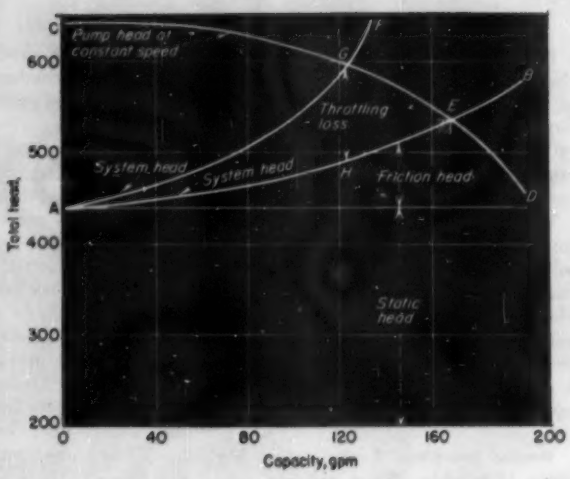
Heat-transfer surfaces of the vent condenser have to be clean. Also, they must be big enough to (1) condense a large amount of the steam-gas mixture and (2) raise incoming water almost to the deaerator temperature.

Deaerator pressure must be above atmospheric so the gas can be vented.

(*Continued on page* 178)



1 Multistage boiler-feed pump rated 257 gpm at a total head of 1360 ft of 265-F water; driven by 125-hp motor



2 System-head curve for a boiler-feed system showing how the pump and friction heads vary with the pump capacity

Use characteristic curves to step up pump performance

If you're buying a new boiler-feed pump be sure to study its characteristic curve and the system-head curve. These important tools are essential in all surveys of horsepower input and parallel operation

By **THOMAS F KEATING**, *Application Engineer, Centrifugal Pump Dept, De Laval Steam Turbine Co*

► A SYSTEM-HEAD CURVE is a graph of the head-capacity characteristics of a piping system. It shows the pressure required to push a given quantity of water through the particular piping system for which it is plotted.

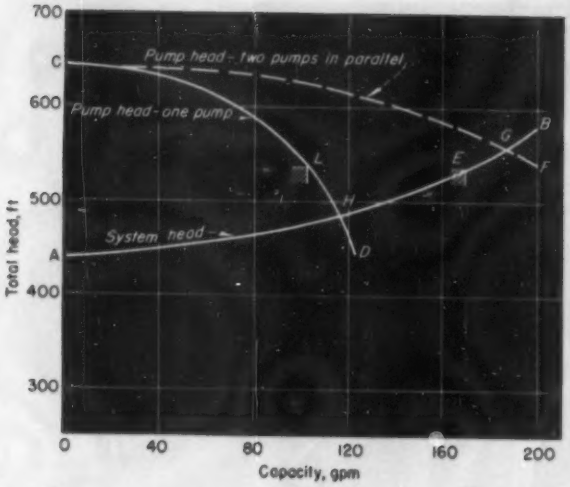
Construction. A simple cold-water application of a system-head curve is a pump lifting water from a well and delivering it to a higher elevation. Total system head against which pump must operate is made up of the static head (vertical lifts) plus a friction head due to flow of water through the pipes.

Static head is obtained by linear measurement. Friction head is found by use of friction-loss tables and a piping diagram showing pipe type, length, diameter and fittings.

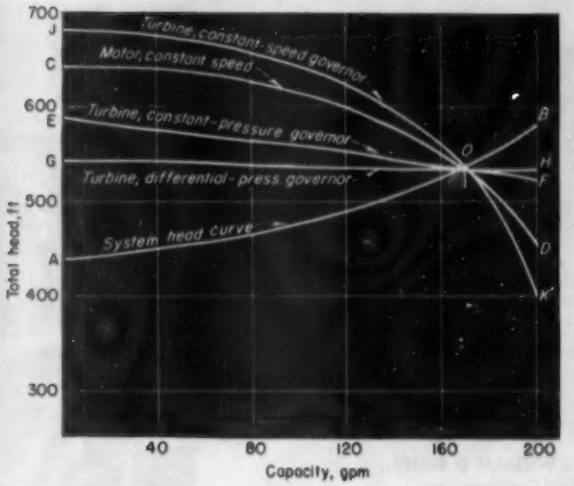
Sum of static and friction heads for all capacities can be shown by a system-head curve: *AB*, Fig. 2. Note that friction portion of the curve rises with increased capacity; this increase is about proportional to the square of the liquid velocity.

Boiler feed. System-head curves also apply to boiler-feed systems. Only difference is that boiler pressure, pump suction pressure (deaerator or heater) and friction loss through heaters, economizer, superheater, regulating valve, etc, must be considered. These are obtainable from equipment builders.

Table, top of facing page, summarizes the pressure conditions existing in an actual job rated at 170 gpm. Using a 3% safety factor, the total head in the system is 535 psig, or 1300 ft of water at 227 F. Note in the table how each unit between the pump and superheater outlet must be considered.



3 Parallel operation of two identical pumps, each rated at 60% of boiler capacity, gives the results shown here



4 Pump characteristic curves obtained with various types of drives and governors. Note variation in shutoff head

Superheater outlet	425.0 psig
Drop in superheater	15.0
Drop in economizer	15.0
Drop in regulating valve	40.0
Drop in feedwater heater	10.0
Drop in piping	15.0
Static elevation	10.0
Pump discharge press. =	530.0
Pump suction press. =	10.9
Total head = difference =	519.1 psig

System-head curve for this unit, Fig. 2, passes through the point representing 1300-ft head and 170-gpm flow. By repeating these calculations at other capacities, the system-head curve *AB* is obtained. It begins at a total head of 440 psig (535 psig less total friction of 95 psig) at zero capacity.

Characteristic curve *CD* of the pump is independent of the system-head curve, Fig. 2. Curve *CD* shows the head at which the pump will deliver any given gpm when run at constant speed. It is a function of pump design only—chiefly impeller diameter and rpm. Point of intersection of the two curves *E*, Fig. 2, is the operating point. The pump automatically adjusts its delivery to this point.

Fluctuating capacities. So long as pump rpm and impeller diameter remain constant, pump must deliver along curve *CD*, Fig. 2. Changes in capacity at part load must be made by varying system-head curve *AB*.

An automatic regulating valve can do this. Partly closing the valve increases the pressure drop across it, creating a different and steeper system-head curve *AF*, Fig. 2. This intersects the pump curve at *G*. Each change in regulating-valve position varies system pressure drop, changing the intersection and pump operating point.

This method of control is inefficient because a pressure drop is added to the system to reduce flow. Amount of pressure drop added is represented by the vertical distance between curves *AB* and *CD*, Fig. 2. For system-head curve *AF*, the loss is *GH*. Horsepower loss can be computed by using the standard relation for centrifugal pumps and substituting the head *GH* and flow at this point.

Parallel operation. Many stations vary capacity by dividing boiler capacity between two or more identical pumps. One pump is run for low capacities, two or more in parallel for intermediate and high capacities. Pumps can be cut in or out automatically as load varies. This permits each pump to operate nearer its point of maximum efficiency at most boiler loads and saves throttling losses met when only one large pump is used.

Fig. 3 shows conditions for two identical pumps, each designed for 60% of boiler capacity. Curve *CD* represents each pump. When run in parallel, the combined capacity is twice that of a single pump. By adding the capacities of the two pumps at each total head, the combined head-capacity curve *CF* is obtained. *G*, point of intersection of *CF* with *AB*, is the new operating point of the two pumps in parallel.

When operating singly, each pump delivers at point *H*. Together the combined capacity is *G*, at a greater total head, Fig. 3. If more pumps are added to the system for capacities beyond *G*, a still higher total head is required. This means each pump will run at a higher total head and lower capacity on its own characteristic curve.

For this type of capacity variation it is desirable to specify pumps with fairly steep head-capacity curves—in the range of 15 to 25%. This assures that delivery and maximum capacity are obtained without requiring each pump to move too far back on its curve to meet the higher combined total head.

Pump curves must rise similarly to nearly the same shutoff pressure, if parallel operation is to be satisfactory. Should one pump have a steeper curve than the other, or different driver characteristics, the pump with the steeper curve hogs the load.

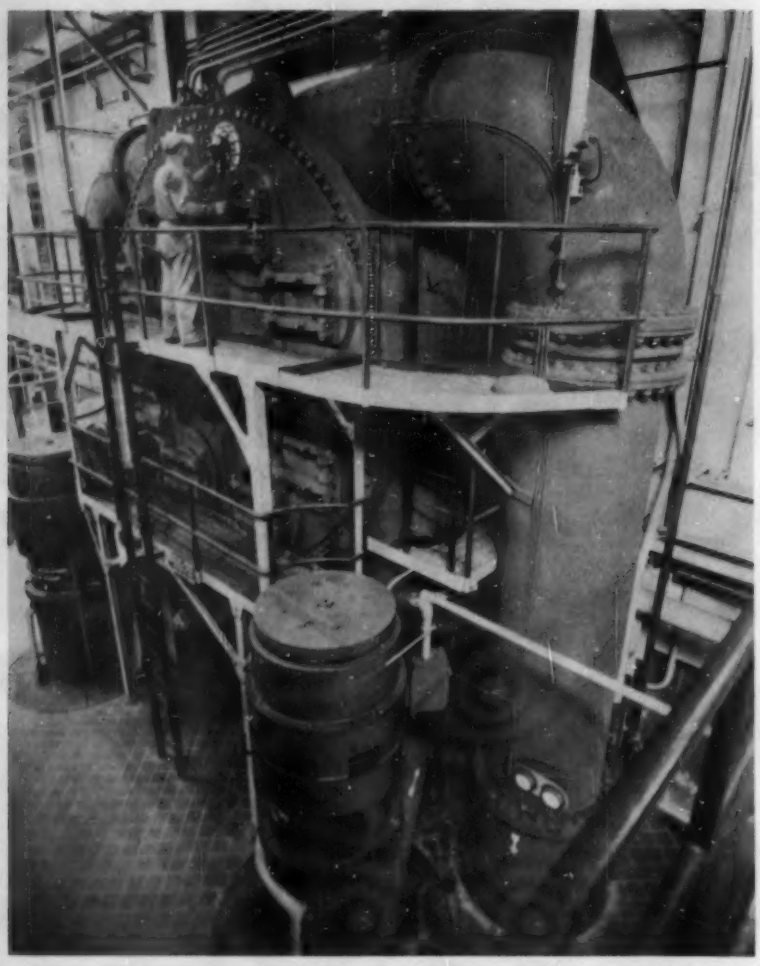
When total head rise is large, pump with flatter curve may be forced back to little or no delivery. Rapid temperature rise in the pump casing, caused by the input horsepower, can lead to liquid flashing in the impeller eye, vapor binding, and seizing of wearing rings and bushings. This trouble can lead to a serious repair job.

Pump manufacturer can advise the minimum safe flow needed, above which no dangerous temperature rise and flashing can occur. A recirculation connection, to bypass the minimum flow when pump capacity is low, eliminates this danger.

Motor size. Since the pumps in Fig. 3 are designed for parallel operation at *L* gpm, singly they deliver at *H* a greater capacity. Motor driving each

(*Continued on page* 190)

By WILLIAM D BISSELL
Plant Superintendent
Somerset Station
Montaup Electric Company



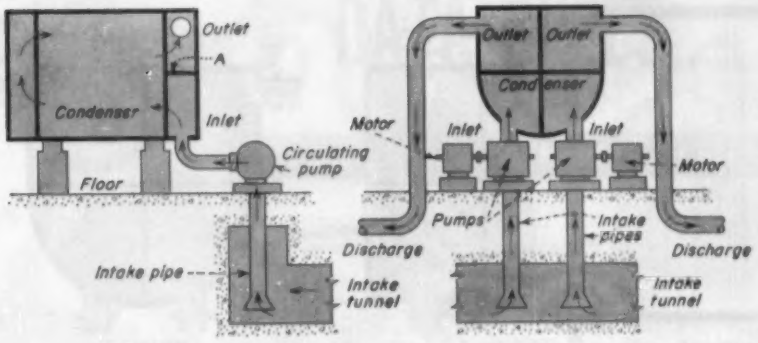
1 No. 5 condenser at Somerset Station has inspection window in outlet waterbox to check on air entrainment in circulating water. Two pumps serve the condenser

Tests lick condenser-tube corrosion

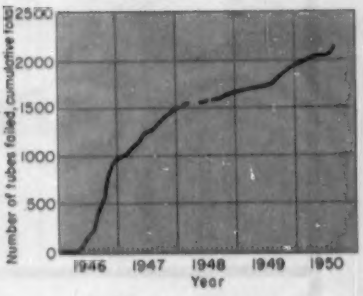
Here's how one central station went about solving a vexing problem in a methodical way. Tube failures were rising so they (1) analyzed the trouble (2) laid out a test program and (3) checked on progress

► OVER A 10-YEAR PERIOD we watched the behavior of tubes working under severe corrosive conditions in two of our 45,000-sq-ft 2-pass surface condensers. The No.-18-gage tubes are 18 ft 3 in. long. We have 1-in.-dia tubes in the condenser installed in 1924 and ⅞-in.-dia tubes in the unit installed in 1928. The tubes are rolled and belled on the inlet ends and packed on the outlet ends. Two horizontal circulating-water pumps serve each condenser. The condensers can run with one half the surface removed from service.

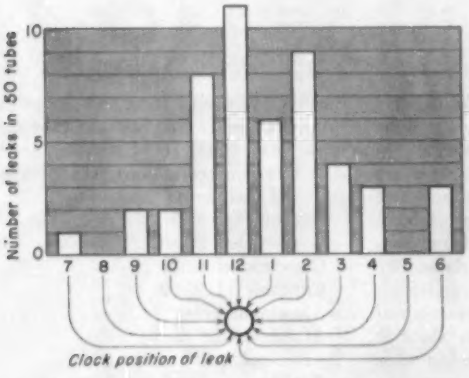
Somerset Station stands on the west side of the Taunton River near Mt. Hope Bay located at the northern end of Narragansett Bay. The brackish condenser water normally contains 75% sea water. Tide varies by about 3 ft. Maximum average water-inlet temperature runs about 75 F with about 15-F rise at condenser outlet during full load. Marine growth in the water includes algae, shell fish, mussels, eels and other types. Some condenser-discharge water recirculates during flood and slack tides.



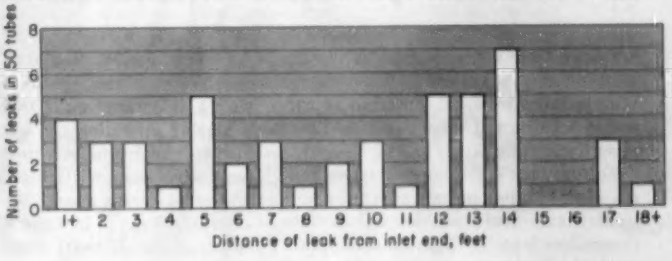
2 Two-pass surface condensers at Somerset Station have divided waterboxes. Each half has its own circulating pump, condenser may operate with half of surface



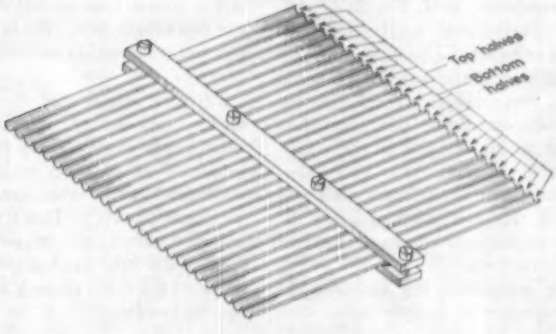
3 Condenser-tube failures rose sharply after retubing unit a year earlier



4 Study of typical groups of 50 sample condenser tubes showed leaks concentrated in upper tube circumference



5 Most tube groups had leaks concentrated in the last three feet of length. This group had fairly general distribution



6 Tube racks kept sample tubes in permanent form for study of corrosion. Each rack held one tube cut up and split with the tube inlet at upper left and outlet at lower right

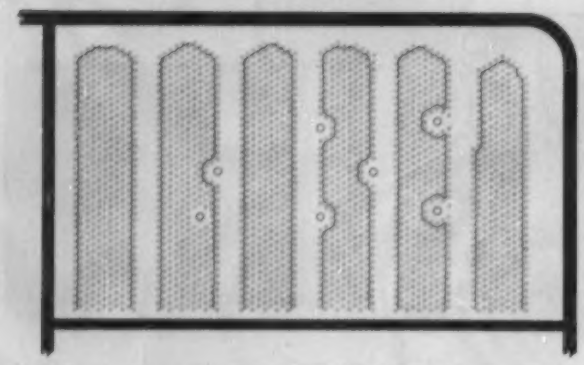
The circulating-water tunnel has two rotary-basket intake screens. We started chlorinating the water in 1945. Diffusers inject chlorine on the intake side of the screens before the water enters the inlet tunnel.

Condenser tubes corroded at a moderate rate up to about 1940 when tube losses increased rapidly. We retubed the sections of the condensers having the most severe corrosion. In 1944, we completely retubed the condensers with arsenical-admiralty material. Subsequent severe corrosion led us to search for a possible constant pattern of causes.

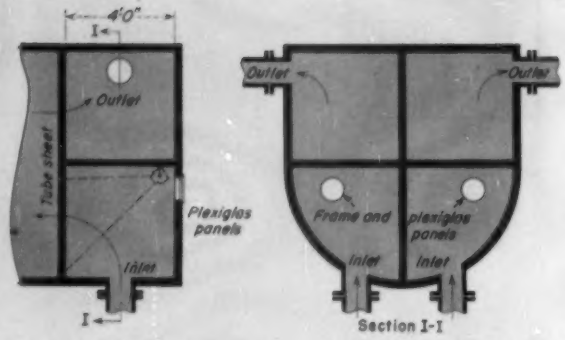
Some tubes failed within about a year after the complete retubing. These first happened in the fall of the year when circulating-water temperature was falling. Throughout the following winter and spring a few additional tubes leaked. When circulating-water temperature started rising, however, tube failures increased rapidly until we were losing as many as 200 per week, Fig. 3.

The tubes were pitted along their entire length, starting within a few inches of the inlet end and becoming more severe at the outlet end, Fig. 5. The corrosion seemed to create a "wash board" unevenness along the tube length, with failures caused by the low point penetrating the tube wall. At first, the upper tubes in the second pass of the condenser were affected the most. Following this, the failures became quite general throughout the second-pass section. The lower tubes in this pass were the last to fail. We then found the tubes in the upper sections of the first pass failing.

Study program. We started a pro-



7 Among the first condenser tubes to fail were those next to (1) blank tube-sheet areas (2) steam lanes (3) stay bolts



8 Aquamarine lamps inside of waterboxes illuminate tube sheets so water action can be watched through the windows

Air entrainment speeds tube corrosion failures

gram of tube replacements in certain sections over week ends. We took out sample tubes to watch progress of corrosion on original tubes, and on tubes recently installed.

To study the corrosion effects, we split the sample tubes in half along the horizontal axis and cut the halves into convenient lengths. These sections were marked for proper continuity and racked up in wooden clamps with the top half adjacent to the bottom half, Fig. 6.

Each racked tube was identified by: date of installation, date of removal, exact location in condenser, flow direction, alloy and manufacturer, service period. These tubes showed that failures occurred quite generally along the tube length, but most failures took place in the last three feet of the tube, Fig. 5.

Classifying the failure incidence around the tube circumferences showed they were located generally from the 8-o'clock position clockwise to the 5-o'clock position. The greatest number were concentrated from 11 to 2 o'clock.

Tubes adjacent to blank spaces in the tube sheet, near steam lanes, or near stay bolts were among the early tubes to fail. Tubes at the top end of tube rows also failed early, Fig. 7.

There was a strong possibility that entrained gases were causing this damage, augmented by water turbulence at the entrance of some tubes. To check this we installed windows of plexiglas at some of the waterbox access doors. Aquamarine lamps inside the waterboxes illuminated the tube sheets and water, Fig. 8.

Results. We found many air bubbles, both large and small, drifting with the water entering the tubes. In some cases violently turbulent water with a constant stream of air bubbles entered the tubes. As water flowed past stay bolts, supports, and blank spaces in the tube sheets, it became quite turbulent.

During operation the waterboxes are always under a minus pressure, so we carefully examined the gasket surfaces on the 44 access doors. We found considerable leakage in some of these. We enlarged the air vents in the condenser-water tunnel to permit freer venting of any accumulated air. The air vents at the top of the reversing waterbox were also enlarged.

To relieve any entrained air in the inlet waterboxes before the water entered the tubes, we drilled 1½-in. holes in the diaphragm separating inlet and outlet waterboxes, at *A*, Fig. 2.

These corrections and alterations markedly reduced the quantity and size of air bubbles in the water. We could duplicate the original air entrainment by opening some of the ¾-in. test valves tapped at various points in the waterbox head.

The number of failures fell off throughout this correction program despite the considerable damage that had already been done.

Testing program. We installed 24 different groups of sample tubes with 50 tubes in each during this investigation. This helped us find the tube material that would stand up best under our operating conditions. Tube types installed included:

Cupronickel 95-5
Cupronickel 90-10
Cupronickel 80-20
Cupronickel 70-30
Aluminum brass
Aluminum bronze
Arsenical brass
Antimonial aluminum brass
Admiralty type A
Admiralty type B
Admiralty, arsenical
Admiralty, antimonial

We found cupronickel 90-10 suited our conditions best. We have now had this tube material in service about seven years.

Periodic samples of these tubes indicate satisfactory operation, which should continue for many years into the future. We had some trouble with the 90-10 Cu-Ni tubes when installing them: they bent so easily. This was corrected, however, when the manufacturer increased the tube hardness to 65B. This stiffened the tubes enough to make them easy to handle.

Would you like to be a *Power* editor?

There is an opening for an Assistant Editor on POWER's editorial staff. He may be an electrical or mechanical engineer, preferably with several years' experience engineering the power services in a manufacturing or process industry. This may be your opportunity. For complete information, turn now to p 5 in this issue.

Power's DATA SHEET

No. 277

Specific volume of air—cu ft per lb

Inches H_2O →	30	25	20	15	10	5	0	−5	−10	−15	−20	−25	−30
PSIA →	15.78	15.60	15.47	15.24	15.06	14.88	14.78	14.52	14.34	14.16	13.98	13.81	13.63
Temp, F ↓													
0	10.78	10.91	11.04	11.16	11.29	11.43	11.57	11.71	11.85	12.01	12.16	12.32	12.48
20	11.25	11.38	11.52	11.65	11.78	11.93	12.07	12.22	12.37	12.53	12.69	12.86	13.02
40	11.72	11.86	12.00	12.13	12.27	12.42	12.58	12.73	12.88	13.05	13.22	13.39	13.57
60	12.19	12.33	12.48	12.62	12.76	12.92	13.08	13.24	13.40	13.58	13.75	13.93	14.11
80	12.66	12.81	12.96	13.10	13.26	13.42	13.58	13.75	13.91	14.10	14.28	14.46	14.65
100	13.13	13.28	13.44	13.59	13.75	13.91	14.09	14.26	14.43	14.62	14.81	15.00	15.20
120	13.60	13.75	13.92	14.07	14.24	14.41	14.59	14.77	14.95	15.14	15.34	15.54	15.74
140	14.06	14.23	14.40	14.56	14.73	14.91	15.09	15.28	15.46	15.67	15.86	16.07	16.28
160	14.53	14.70	14.88	15.04	15.22	15.41	15.60	15.79	15.98	16.19	16.39	16.61	16.82
180	15.00	15.18	15.36	15.53	15.71	15.90	16.10	16.30	16.49	16.71	16.92	17.14	17.37
200	15.47	15.65	15.84	16.02	16.20	16.40	16.60	16.81	17.01	17.23	17.45	17.68	17.91
220	15.94	16.12	16.32	16.50	16.70	16.90	17.11	17.32	17.53	17.75	17.98	18.22	18.45
240	16.41	16.60	16.80	16.99	17.19	17.40	17.61	17.83	18.04	18.28	18.51	18.75	19.00
260	16.88	17.07	17.28	17.47	17.68	17.89	18.11	18.33	18.56	18.80	19.04	19.29	19.54
280	17.35	17.55	17.76	17.96	18.17	18.39	18.62	18.84	19.07	19.32	19.57	19.82	20.08
300	17.82	18.02	18.24	18.44	18.66	18.89	19.12	19.35	19.59	19.84	20.10	20.36	20.63
320	18.29	18.49	18.72	18.93	19.15	19.39	19.62	19.86	20.11	20.37	20.63	20.90	21.17
340	18.76	18.97	19.20	19.42	19.64	19.88	20.12	20.37	20.62	20.89	21.16	21.43	21.71
360	19.23	19.44	19.68	19.90	20.14	20.38	20.63	20.88	21.14	21.41	21.69	21.97	22.25
380	19.69	19.92	20.16	20.39	20.63	20.88	21.13	21.39	21.65	21.93	22.21	22.50	22.80
400	20.16	20.39	20.64	20.87	21.12	21.37	21.64	21.90	22.17	22.45	22.74	23.04	23.34
420	20.63	20.86	21.12	21.36	21.61	21.87	22.14	22.41	22.69	22.98	23.27	23.58	23.88
440	21.10	21.34	21.60	21.84	22.10	22.37	22.64	22.92	23.20	23.50	23.80	24.11	24.43
460	21.56	21.81	22.08	22.33	22.59	22.87	23.15	23.43	23.72	24.02	24.33	24.65	24.97
480	22.04	22.29	22.56	22.81	23.08	23.36	23.65	23.94	24.23	24.54	24.86	25.18	25.51
500	22.51	22.76	23.04	23.30	23.58	23.86	24.16	24.45	24.75	25.07	25.39	25.72	26.05
520	22.98	23.23	23.51	23.79	24.07	24.36	24.66	24.96	25.27	25.59	25.92	26.26	26.60
540	23.45	23.71	23.99	24.27	24.56	24.85	25.16	25.47	25.78	26.11	26.45	26.79	27.14
560	23.92	24.18	24.47	24.76	25.05	25.35	25.67	25.98	26.30	26.63	26.98	27.33	27.68
580	24.39	24.66	24.95	25.24	25.54	25.85	26.17	26.49	26.81	27.15	27.51	27.86	28.23
600	24.86	25.13	25.43	25.73	26.03	26.35	26.67	27.00	27.33	27.68	28.04	28.40	28.77
620	25.33	25.60	25.91	26.21	26.52	26.84	27.18	27.51	27.85	28.20	28.57	28.94	29.31
640	25.79	26.08	26.39	26.70	27.01	27.34	27.68	28.02	28.36	28.72	29.09	29.47	29.86
660	26.26	26.55	26.87	27.18	27.51	27.84	28.18	28.53	28.88	29.24	29.62	30.01	30.40
680	26.73	27.03	27.35	27.67	28.00	28.34	28.69	29.04	29.39	29.76	30.15	30.54	30.94
700	27.20	27.50	27.83	28.16	28.49	28.83	29.19	29.55	29.91	30.29	30.68	31.08	31.49
720	27.67	27.97	28.31	28.64	28.98	29.33	29.69	30.06	30.43	30.81	31.21	31.62	32.03
740	28.14	28.45	28.79	29.13	29.47	29.83	30.20	30.56	30.94	31.33	31.74	32.15	32.57
760	28.61	28.92	29.27	29.61	29.96	30.32	30.70	31.07	31.46	31.85	32.27	32.69	33.11
780	29.08	29.40	29.75	30.10	30.45	30.82	31.20	31.58	31.97	32.38	32.80	33.22	33.66
800	29.55	29.87	30.23	30.58	30.95	31.32	31.71	32.09	32.49	32.90	33.33	33.76	34.20
820	30.02	30.34	30.71	31.07	31.44	31.82	32.21	32.60	33.01	33.42	33.86	34.30	34.74
840	30.49	30.82	31.19	31.56	31.93	32.31	32.71	33.11	33.52	33.94	34.39	34.83	35.29
860	30.95	31.29	31.67	32.04	32.42	32.81	33.22	33.62	34.04	34.46	34.92	35.37	35.83
880	31.42	31.77	32.15	32.53	32.91	33.31	33.72	34.13	34.55	34.99	35.44	35.90	36.37
900	31.89	32.24	32.63	33.01	33.40	33.81	34.22	34.64	35.07	35.51	35.97	36.44	36.92
920	32.36	32.71	33.11	33.50	33.89	34.30	34.73	35.15	35.59	36.03	36.50	36.98	37.46
940	32.83	33.19	33.59	33.98	34.39	34.80	35.23	35.66	36.10	36.55	37.03	37.51	38.00
960	33.30	33.66	34.07	34.47	34.88	35.30	35.73	36.17	36.62	37.08	37.56	38.05	38.54
980	33.77	34.14	34.55	34.96	35.37	35.79	36.24	36.68	37.13	37.60	38.09	38.58	39.09
1000	34.24	34.61	35.03	35.44	35.86	36.29	36.74	37.19	37.65	38.12	38.62	39.12	39.63
1020	34.71	35.08	35.51	35.93	36.35	36.79	37.24	37.70	38.17	38.64	39.15	39.66	40.17
1040	35.18	35.56	35.99	36.41	36.84	37.29	37.75	38.21	38.68	39.16	39.68	40.19	40.72
1060	35.65	36.03	36.47	36.90	37.33	37.78	38.25	38.72	39.20	39.69	40.21	40.73	41.26
1080	36.12	36.51	36.95	37.38	37.83	38.28	38.75	39.23	39.71	40.21	40.74	41.26	41.80
1100	36.59	36.98	37.43	37.87	38.32	38.78	39.26	39.74	40.23	40.73	41.27	41.80	42.35
1120	37.06	37.45	37.91	38.35	38.81	39.27	39.76	40.25	40.75	41.25	41.80	42.34	42.89
1140	37.52	37.93	38.39	38.84	39.30	39.77	40.26	40.76	41.26	41.78	42.32	42.87	43.43
1160	37.99	38.40	38.87	39.32	39.79	40.27	40.77	41.27	41.78	42.30	42.85	43.41	43.97
1180	38.46	38.88	39.35	39.81	40.28	40.77	41.27	41.78	42.29	42.82	43.38	43.94	44.52
1200	38.93	39.35	39.83	40.30	40.77	41.26	41.77	42.29	42.81	43.34	43.91	44.48	45.06
ΔV/F	0.0235	0.0237	0.0240	0.0243	0.0246	0.0249	0.0252	0.0255	0.0258	0.0261	0.0265	0.0268	0.0271

PP

12	13	14	15
2	3	3	3
5	5	6	6
7	8	8	9
10	10	11	12
16	17	18	19
3	3	4	4
6	7	7	8
10	10	11	11
13	14	14	15
20	21	22	23
4	4	4	5
8	8	9	9
12	13	13	14
16	17	18	18
24	25	26	27
5	5	5	5
10	10	10	11
14	15	16	16
19	20	21	22
28	29	30	31
6	6	6	6
11	12	12	12
17	17	18	19
22	23	24	25
32	33	34	35
6	7	7	7
13	13	14	14
19	20	20	21
26	26	27	28
36	37	38	39
7	7	8	8
14	15	15	16
22	22	23	23
29	30	30	31
40	41	42	43
8	8	8	9
16	16	17	17
24	25	25	26
32	33	34	34
44	45	46	47
9	9	9	9
18	18	18	19
26	27	28	28
35	36	37	38
48	49	50	51
10	10	10	10
19	20	20	20
29	29	30	31
38	39	40	41
52	53	54	55
10	11	11	11
21	21	22	22
31	32	32	33
42	42	43	44
56	57	58	59
11	11	12	12
22	23	23	24
34	34	35	36
45	46	46	47

► THIS TABLE shows specific volumes for air at temperatures from 0 to 1200 F, and pressures from 30 to −30 in. water gage. These values are figured from the universal gas equation for air: $PV = 53.3T$. For many purposes these figures can also be used for combustion gases from burning of oil and coal. Their gas constants differ by only about 3 percent from that of air.

The table is handy for figuring problems where air and gases exchange heat, as in air heaters, dust collectors and economizers. The table eliminates refiguring the volume with each change in temperature and pressure.

To aid interpolating in the table, last line at bottom gives change in volume per degree of temperature for each pressure. To find intermediate values: first interpolate vertically between temperatures, then interpolate horizontally between pressures. Side table of proportional parts (*PP*) helps in horizontal interpolation.

HENRY DEPAOLI *W. Reading, Pa.*

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Another *first* for RILEY

three half-million pounds per hour RILEY steam generating units will be the first large units designed to burn

FLUID COKE*

*

Process . . . Fluid coking uses the fluidized solids technique used in catalytic cracking (*The Oil and Gas Journal, August 17, 1953, page 74*). But here the coke itself is fluidized. In the reactor vessel, the residual feed stock is charged to a fluidized bed of hot coke particles. The heavy hydrocarbons are thermally cracked, yielding light ends, gasoline, and fuel oils, which are withdrawn from the reactor after passing cyclone separators. Heavy gas oil from the fractionator is recycled to the reactor with fresh feed.

The coke which is formed in the thermal-cracking process is laid down on the finely divided coke particles. A stream of coke is continuously withdrawn to a second vessel, the coke burner. Here it is fluidized with air, and a portion of the coke is burned.

A fraction of the unburned, heated coke particles is returned to the reactor to provide the temperature necessary to carry out the thermal cracking of charge stock. New coke production is withdrawn from the burner vessel as a stream of hard, glossy coke grains which correspond roughly in size to the sand in an hourglass.

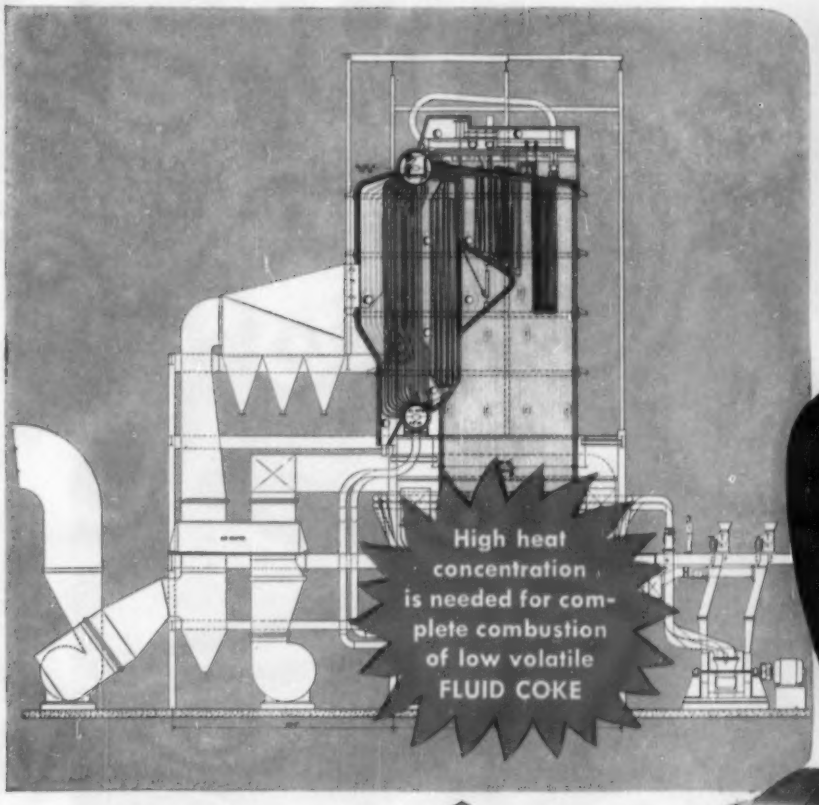
Clipped from *Oil & Gas Journal*, Mar. 31, 1955

A giant reactor to be installed at Tide Water Associated Oil Company's new 130,000 barrel-per-day Delaware Flying-A-refinery near Wilmington, will produce hundreds of tons of fluid coke daily which will be used as a fuel for three Riley steam generating units each with continuous operating capacities of a half million pounds of steam per hour.

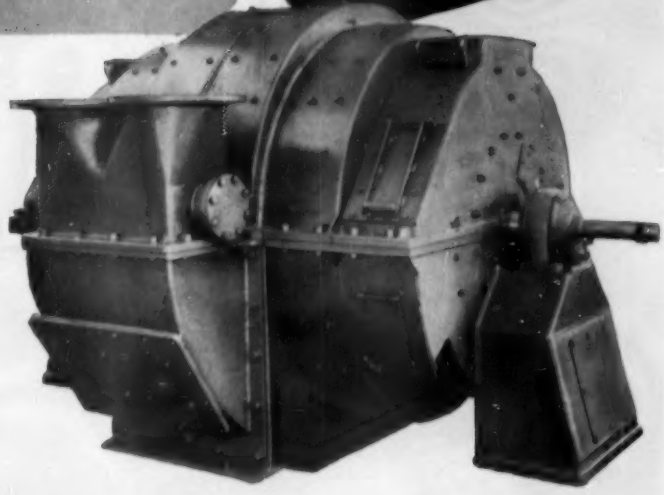
These three Riley units will be the first large units designed to burn fluid coke; they were selected for the new refinery by Tide Water and C. F. Braun & Co., the engineering company engaged for the design of the refinery, on the basis that the method and equipment offered by Riley would most satisfactorily burn the new fuel.

The Riley fluid coke burning equipment features a new Riley furnace design, new type Riley burners and Riley Pulverizers.

Tests have been successfully conducted on Riley equipment similar to that to be installed at the new refinery. Now, other companies considering the fluid coking process can be assured that Fluid Coke can be used as a satisfactory and economical fuel for power plant steam generating equipment.



RILEY EQUIPMENT OVERCOMES DIFFICULT BURNING CHARACTERISTICS OF FLUID COKE



A furnace designed to effect a high heat concentration is needed to satisfactorily burn low volatile pulverized FLUID COKE. The coke will be fired by new type Riley burners in specially designed furnaces of three Riley "RX" type steam generating units each with a continuous steam capacity of 500,000 lbs/hr; 1425 psig., 950 F. at super-heater outlet.

Because of FLUID COKE'S extreme hardness (even harder than anthracite), the small size and round shape of its grains, the attrition action in Riley Pulverizers is ideal for producing the degree of fineness for satisfactory combustion.

A survey of your plant by a consulting engineer could show ways of making surprising savings in your power costs.

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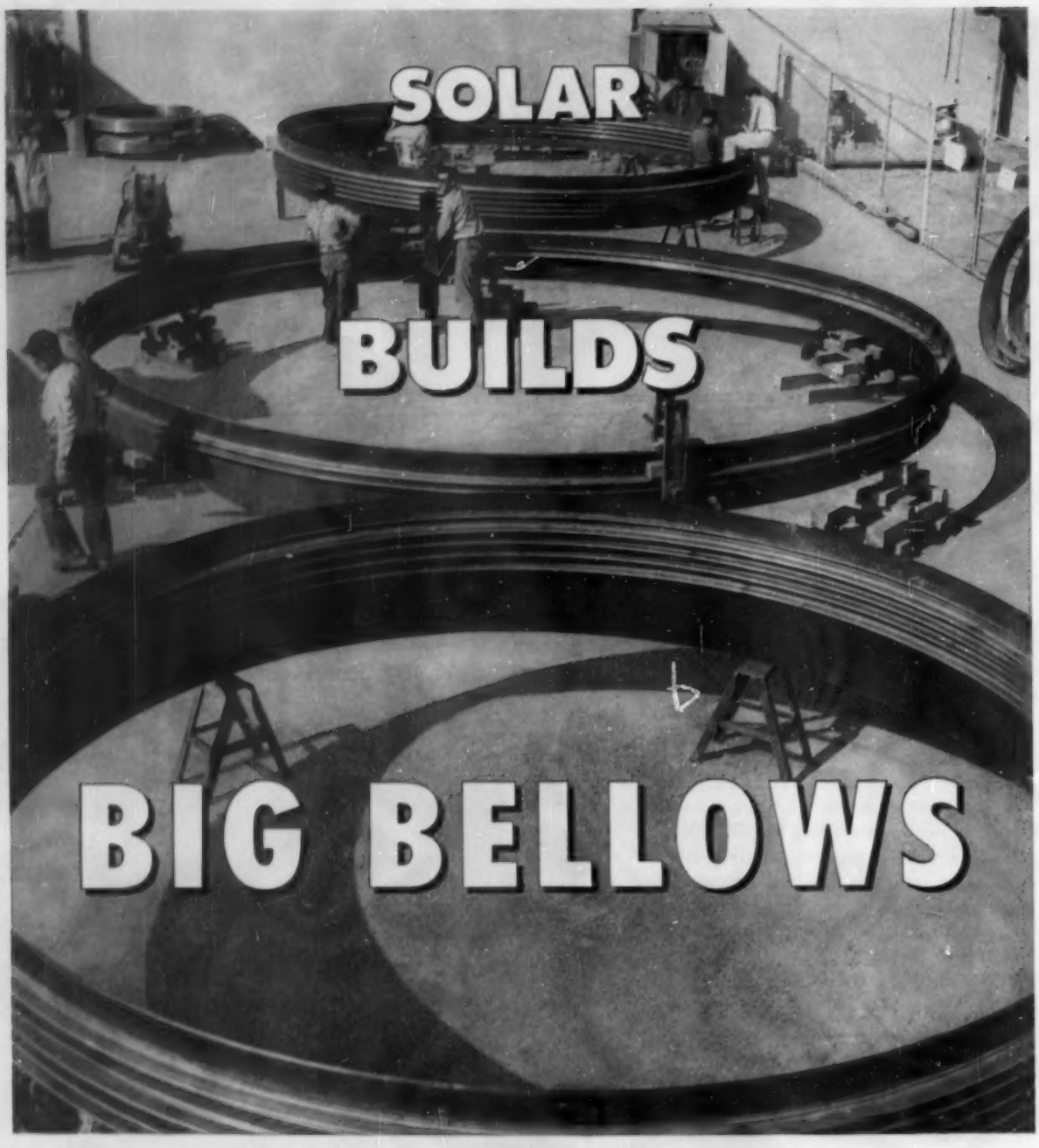

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These giant bellows are only one example of Solar's versatile production of expansion joints. There are also small bellows units in standard pipe sizes down to ⅜ inch for many applications. Further, Solar builds all major types of bellows—including convoluted for low pressure use and rugged U-span for heavy industrial needs.

In the petroleum, power, and many other industries, Solar bellows and expansion joints have been proven durable and economical. Both standard units and special designs are described in Sola-Flex catalogs. Experienced Solar engineering teams are available to help with unusual applications. Whether they call for giant expansion joints or tiny bellows—bring your problems of pressure and temperature to Solar. You'll get the right answer! Address Solar Aircraft Company, Dept. B-34, San Diego 12, California

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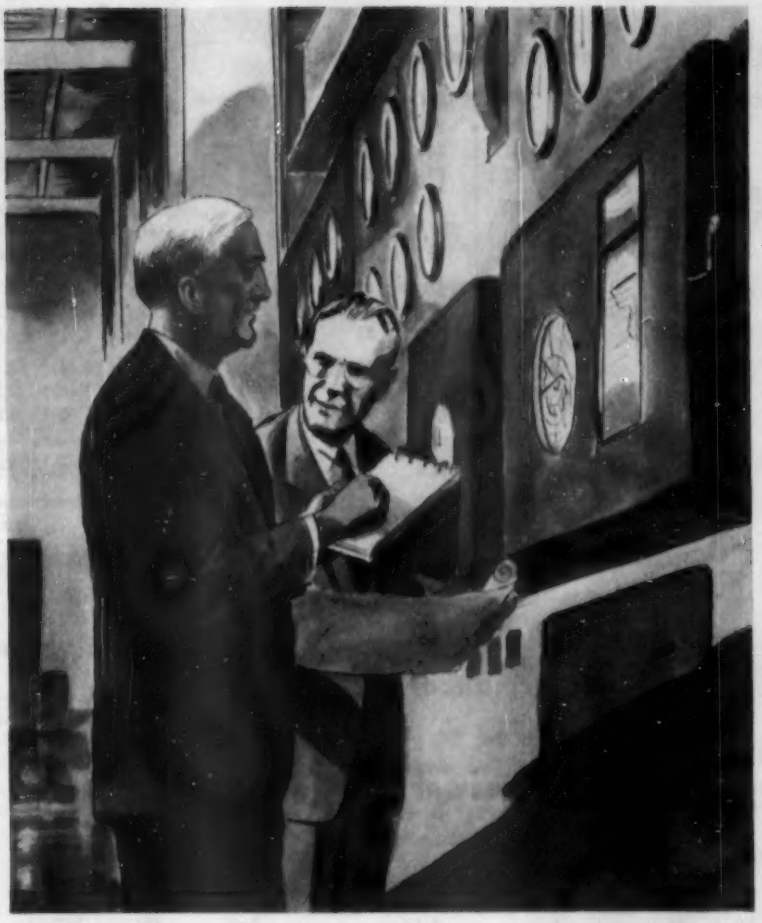


Why don't operators get efficiency bonus?

H C Todd, plant engineer gives you his answer

EDITOR'S NOTE: *In the March issue we said: "Suppose a plant runs at 80% efficiency, then the power engineer ups this to 84%, saving large sums in a big plant. What kind of bonus system will justly reward him and his department? Why don't power engineers come in for their share of this gravy?"*

► BASIC CONCEPT of any wage incentive is to pay a worker for putting extra effort into his job. If standard or average performance requires 60 pieces per hour and a worker produces 70, he's certainly entitled to extra pay. On the other hand, should he fall below standard and produce only 50 pieces, he should, of course, still be paid base rate.

There are many incentive plans for production. Supervisory premium is usually tied into these plans. Then as amount of work increases, supervisors also get paid for their part. All such systems answer the purpose of a yardstick measuring labor's efficiency, and nothing else.

Steam. Now let's move into the boiler room. Some states have operating codes, requiring certain licenses. These are issued on examination, to fit individual operating conditions. Boiler on the line, for example, must be under care of a licensed watch engineer or fireman and sometimes both, if power is generated. Under these conditions there's little to be done about using labor.

Here power plant is under a chief engineer, who calculates (or should) a daily boiler efficiency. He should also take needed steps to maintain it at peak. There's little the operating personnel can do other than make indicated changes in draft, firing rate, etc, to contribute to this figure. So this should rule operators out of any bonus award and confine it strictly to the chief.

Taken as a group, the chief, engineers and firemen are in a class by themselves. They all take great pride in their plant and are usually alert to changes in operating conditions. This attitude does

I: Boiler efficiency in percent

Month	1948	1949	1950	1951	1952	1953	1954
Jan	92	74	76	73	84	73	70
Feb	77	70	81	76	73	73	91
March	51	82	73	87	85	73	76
April	73	75	70	59	67	67	99
May	79	71	68	67	92	56	64
June	64	73	67	84	83	73	64
July	53	58	61	67	89	63	74
Aug	63	76	68	62	64	77	68
Sept	70	73	78	69	82	57	73
Oct	87	74	65	76	73	69	78
Nov	77	82	73	76	72	89	74
Dec	75	83	70	79	71	76	95
Average	72.4	74.8	72.2	74.4	76.2	72.1	78.9

Source: Calculated from power-plant report

II: Cost per thousand pounds of steam in dollars

	1952		1953			1954	
Month	Steam M lb, $	5-yr av M lb, $	Steam M lb, $	Change %	5-yr av M lb, $	Steam M lb, $	Change %
Jan	1.59	1.62	1.68	+4	1.69	1.97	+17
Feb	2.01	1.80	1.73	–4	1.81	2.06	+14
Mar	1.75	1.77	1.67	–6	1.72	2.14	+24
Apr	2.45	2.48	2.19	–12	2.42	3.01	+24
May	6.47	4.16	5.04	+24	4.67	4.72	+1
June	5.44	5.68	5.17	–9	5.67	8.33	+47
July	5.43	7.25	5.25	–28	6.24	6.82	+9
Aug	6.04	6.74	5.65	–16	6.55	6.12	–7
Sept	4.57	5.57	6.30	+13	5.91	4.81	–19
Oct	2.44	2.46	5.65	+23	3.10	3.51	+13
Nov	3.40	2.23	3.20	+43	2.36	2.17	–8
Dec	1.90	1.84	2.33	+27	1.85	1.64	–11
Aver	2.78	2.54	2.86	+13	2.65	2.84	+7

Source: Calculated from Tables V and VI

Over-all performance must be measured to give you a full answer

much to keep boiler efficiency at top levels. If these conclusions are right, an incentive bonus has no place in the boiler room as it cannot pay its own way.

If you can't go along with that statement, let's see what yardstick we have to measure performance and pay a bonus. Table I shows that boiler efficiency alone is about the least desirable basis to use. Of course, we want and expect peak performance at all times. But don't overlook the fact that engineers designed the plant for something in excess of maximum winter load needs. So don't expect winter efficiencies when heat is off during summer and boiler operates at, say, 30% of rating.

Inventory errors give you the efficiency fluctuations in Table I, resulting in abnormally high or low figures. Too, boiler efficiency is only one part of the operation. It's similar to productive departments measuring the "do" part of an operation, and neglecting the "make ready" and "put away" factors.

What does management expect from its steam plant? That's easy—they expect steam! Steam on time to meet production and heating schedules, in quantity and quality and at minimum cost. Simple to write but not so easy to execute. You can set up a firing schedule to handle the time element. And we'll have to assume plant is designed for needed quantity and quality. That leaves us with cost factor, which measures *over-all* performance of plant. That'll be our yardstick.

Industries with a modern accounting system usually make up monthly operating-expense statements by cost centers. Such statements should show following items for a boiler room: Indirect labor, salaries, overtime premium, vacation and holiday wages, compensation insurance, payroll taxes, group insurance, supplies, telephone charges, professional services, maintenance and repairs, water, fuel costs, general insurance, taxes, depreciation and sundry expense.

Individually, these figures show where and by how much we went wrong. Collectively, and regardless of whether they are controllable, they show what it cost to do business—that of delivering steam, Table VI.

Reference to our flowmeter integrator tells us how much business we did, Table V. Now, by dividing the total steam generated (not delivered because we also have accessories to run), ex-

V: Steam generated in thousands of pounds

	1952		1953			1954	
Month	Steam M lb	5-yr av M lb	Steam M lb	Change %	5-yr av M lb	Steam M lb	Change %
Jan	2,441	2,385	2,118	–11	2,090	2,275	+9
Feb	2,187	2,160	1,766	–18	2,020	1,909	–6
Mar	2,087	2,010	1,856	–8	1,975	2,055	+4
Apr	1,282	1,161	1,402	+21	1,188	1,353	+14
May	895	803	485	–40	698	631	–10
June	455	470	460	–2	470	410	–13
July	464	314	490	+56	378	415	+10
Aug	501	392	391	0	406	389	–4
Sept	645	486	478	–2	482	565	+17
Oct	1,266	1,088	773	–29	975	758	–22
Nov	1,449	1,592	1,437	–10	1,532	1,616	+5
Dec	2,009	1,955	1,856	–5	1,930	1,990	+3
Total	15,681	14,840	13,215	–9	14,130	14,366	+2

Source: Flowmeter integrator (adjusted and disguised)

III: Comparative weather in degree days

Month	1952 Deg days	1952 5-yr aver	1953 Deg days	1953 Change %	1953 5-yr aver	1954 Deg days	1954 Change %
Jan	880	894	832	−7	819	1036	+26
Feb	821	843	755	−10	798	688	−14
Mar	766	752	665	−12	743	729	−2
Apr	334	402	417	+4	396	360	−9
May	176	170	116	−32	152	198	+30
June	10	18	17	−6	18	9	−50
July	0	0	0	0	0	0	0
Aug	1	0	0	0	0	0	0
Sept	13	43	39	−9	47	44	−6
Oct	325	225	168	−25	201	213	+6
Nov	501	518	458	−12	534	569	+7
Dec	821	825	746	−10	811	898	+11
Total	4648	4690	4213	−10	4520	4744	+5

Source: U.S. Weather Bureau, New York, N. Y.

IV: Bonus earned in points

Month	1953	1954
Jan	4	0
Feb	10	0
Mar	10	0
April	9	0
May	8	5
June	10	0
July	6	0
Aug	10	3
Sept	0	10
Oct	0	8
Nov	7	10
Dec	0	10
Total	74	46

Source: Tables II and VI

Method of award

4 points earned if cost per M is less than same month previous year.

3 points earned if operating expense is less than same month previous year.

2 points earned if cost per M is less than 5-yr average for same month.

1 point earned if operating expense is less than 5-yr average for same month.

VI: Operating expense in dollars

Month	1952 Operation, $	1952 5-yr av, $	1953 Operation, $	1953 Change %	1953 5-yr av, $	1954 Operation, $	1954 Change %
Jan	3,881	3,870	3,554	−8	3,540	4,490	+27
Feb.	4,394	3,895	3,052	−22	3,670	3,927	+7
Mar	3,648	3,555	3,095	−13	3,405	4,391	+29
Apr	3,139	2,875	3,067	+7	2,880	4,067	+39
May	5,781	3,340	2,437	−27	3,255	2,975	−9
June	2,471	2,665	2,379	−11	2,660	3,412	+28
July	2,515	2,275	2,577	+13	2,355	2,826	+20
Aug	3,025	2,640	2,211	−16	2,655	2,446	−8
Sept	2,948	2,710	3,008	+11	2,850	2,722	−4
Oct	3,082	2,680	4,373	+63	3,025	2,658	−12
Nov	4,933	3,560	4,598	+29	3,620	3,503	−3
Dec	3,823	3,670	4,317	+18	3,580	3,263	−9
Total	45,640	37,700	38,668	+3	37,500	40,680	+8

Source: Expense statement (adjusted and disguised)

pressed as thousands of pounds, into the total operating expense we end up with a cost per thousand pounds of steam, Table II. This is nothing more than operating engineers have been doing for years. But as long as we have such a figure, let's apply it to our question and see what happens.

We must agree that some of our costs are fixed: depreciation, taxes, general insurance. Others are variable but, as used in cost per 1000 lb, only partly so: labor, salaries, overtime, vacations, compensation insurance, payroll taxes, group insurance, telephone.

Of these, the last four depend on the first four. Should the first four vary, because of addition of a second and third shift, or vice versa, they would automatically be offset by an increased, or decreased, amount of steam generated and tend to level off in cost per M.

Supplies, maintenance and repairs, and fuel costs are our major variables. Smart usage and purchase should control the supply account. Starting a preventive maintenance program, if you don't have one, will cut down on repair costs. You already know what keeps fuel costs down—maximum operating efficiency. Now we've completed the cycle and arrived back at the original question by devious but logical reasoning. We're using boiler efficiency in our consideration but only as it affects our over-all cost of doing business.

Some may argue that plant activity and weather conditions have a major bearing on steam generated and operating expenses and, therefore, on cost per 1000 lb. True, they have an effect, but very minor. In time, degree days level off even if compared month by month, as you can see in Table III. Exception testing this rule would be January 1954 at 26% colder than 5-year average. May and June, 30% colder and 50% warmer, respectively, can be dismissed as heat was off anyway. Plant activity is, to our notion, in same category. Although plant activity may show an apparent steady decline from the 5-year average (because of technological developments) the steam must be there awaiting delivery. So amount actually used has little bearing on cost per 1000 lb.

In any event, using these two variables (plant activity and weather) only complicates calculation. They contribute little to our over-all accuracy. This isn't a time-study approach, so further refinement seems needless.

Let's get back to Table II to evaluate the performance shown in cost per 1000 lb of steam. For simplicity, we'll assume operating conditions similar to same month of preceding year. If we do a good job of cost reduction, our main target should be to operate at same, or lower, cost per M.

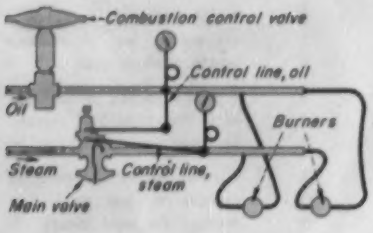
Our next target should be to operate

(*Continued on page* 186)

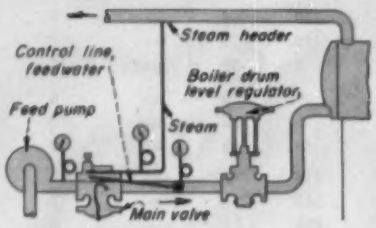
OPERATORS' NOTEBOOK 87

Here's your pressure-pilot

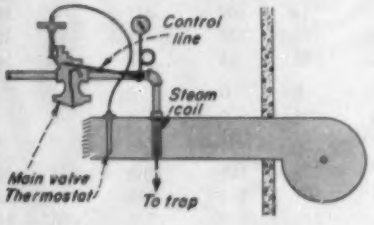
Applications are many and varied



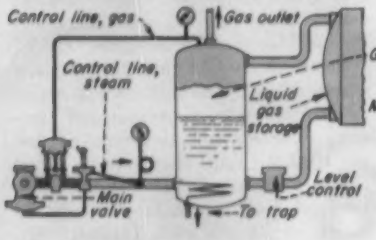
Oil burner. Atomizing steam pressure is regulated to oil burner at preset amount, above the oil pressure. Steam pressure under diaphragm is balanced by oil pressure and adjusting spring on top. Once set, adjusting spring force is constant. As combustion-control valve raises oil pressure, regulator raises steam pressure until pilot diaphragm is again balanced. Improves combustion.



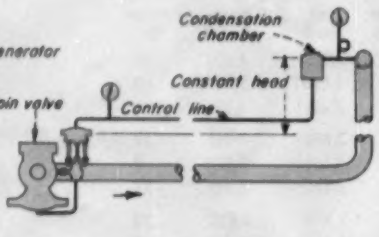
Boiler feedwater. Valve controls pressure drop across boiler level-regulator when boiler is fed by motor-driven centrifugal pump. As demand for feed decreases and level-regulator throttles, main regulator also throttles, offsetting increased pump-discharge pressure. It maintains inlet pressure to level-regulator at constant differential over boiler pressure. Self-operated, no air needed.



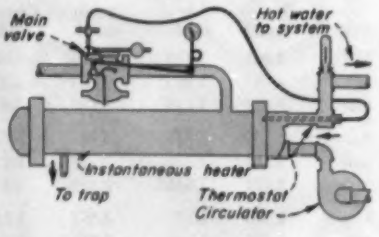
Makeup air. Here we provide control of makeup-air temperature with varying outdoor-air temperatures. A maximum coil pressure is set on pressure control of pilot to heat incoming air to needed temperature at lowest outdoor temperatures. Thermostat element then throttles the pilot (and therefore main valve) to maintain constant outlet-air temperature needed. Only valve needed.



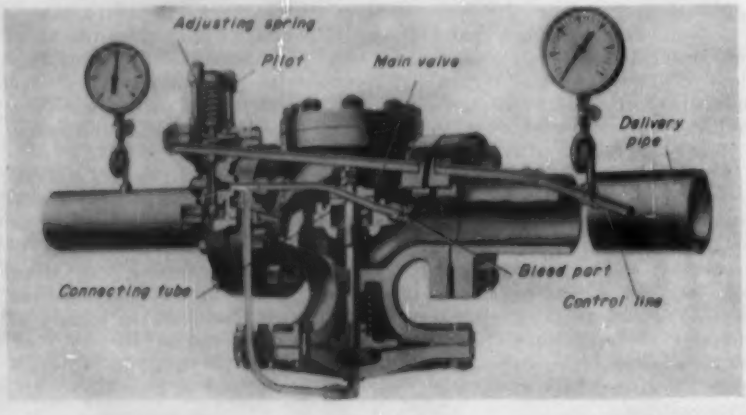
Gas-pressure control. Here main pressure is constant from propane-gas generator; valve limits steam pressure in the generator. Usually pilot double spring controls main valve, admitting just enough steam to maintain set gas pressure. When gas pressure drops and calls for more steam, the pilot (small) limits steam pressure on exchanger to the pressure for which pilot is set.



Remote regulator. Hookup regulates pressure at a distant point from regulator itself. Slight increase in controlled pressure throttles the pilot, which in turn throttles the main valve. One big advantage is there's no limitation on distance so long as control pipe is solidly filled with water. Use hookup where noise or appearance isn't too important at accessible locations.



Hot water. Valve controls converters for hot-water heating systems. Pressure element of pilot limits heater pressure on start-up with cold water. As return temperatures increase, thermostat throttles the pilot and main valve. That maintains a constant converter outlet temperature. Operation of this hookup does not depend on outside power source. Modulating control saves steam.

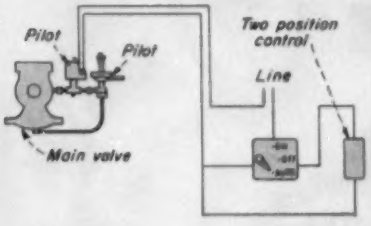


Now let's look

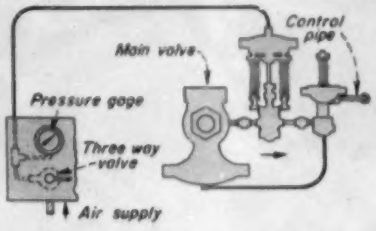
One big difference in this regulator from those in previous Operators' Notebooks is that its pilot valve is on outside, not in housing. Here, pilot can be removed from valve in a few minutes, replaced if needed. Maintenance men can thus have several cleaned pilots on a shelf, ready to service a large number of pressure regulators throughout

single-seated packless regulator

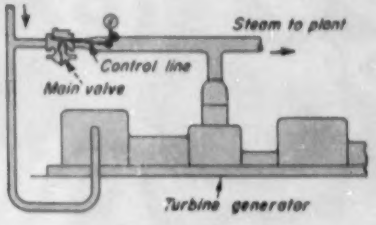
By STEVE ELONKA, *Associate Editor*



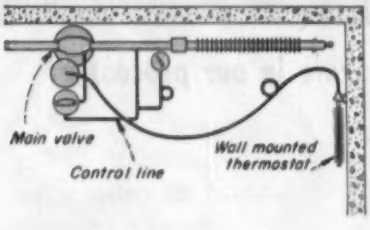
Electric shutoff. Remote shutoff is by electric control where frequent interruption is needed. When electric power is supplied to the pilot, it opens. That admits steam to the pilot and allows it to control the main valve as a simple pressure regulator. Here interrupting current flow allows pilot to close. That closes main valve. Costs less than separate electrically operated shutoff.



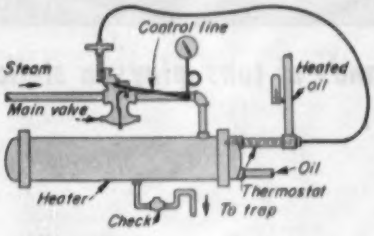
Pressure shutoff. Hook-up provides remote shutoff by fluid pressure where frequent interruption is needed. When pressure is applied to diaphragm (double spring), pilot closes. That denies pilot (single spring) steam needed to open main valve. Pilot, when unloaded, opens, which allows it to control main valve as a simple pressure regulator. Can operate a distance from regulator.



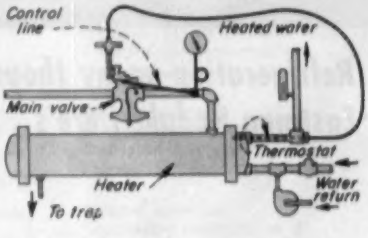
Makeup steam. Valve supplies steam to turbine exhaust main. When turbine load decreases and turbine exhaust is not enough for steam load, very slight drop in exhaust pressure causes pressure regulator to feed correct amount of steam to meet demand. Here pilot-operated accuracy avoids undue pressure drop before makeup starts, which makes steam flow to plant very constant.



Temperature control. This is economical hookup for warehouses, shops, kilns and other spaces where appearance is not too important. Pilot controls steam flow to the installed radiation that's indicated by the temperature at thermostat bulb. Pilot controls the pressure on the heating surface when the temperature pilot opens wide, as at start-up, for example. No air or electricity needed.



Oil preheater. Here's way to control fuel-oil temperature from an oil preheater. When the oil temperature is near the setting of thermostat element, the element begins to remove pressure loading (imposed by the pressure-loading spring) from the steam-pressure control diaphragm. That allows the valve to throttle and control. Limiting pressure minimizes carbonization here.



Domestic hot water. Valve controls hot-water temperature from a tankless heater as shown. Rising water temperature resets pressure loading. This reduces the heater steam pressure to that needed to maintain the load. This hook-up eliminates need for a second regulator of the pressure-reducing type. Thermal element is built to withstand accidental over-temperatures.

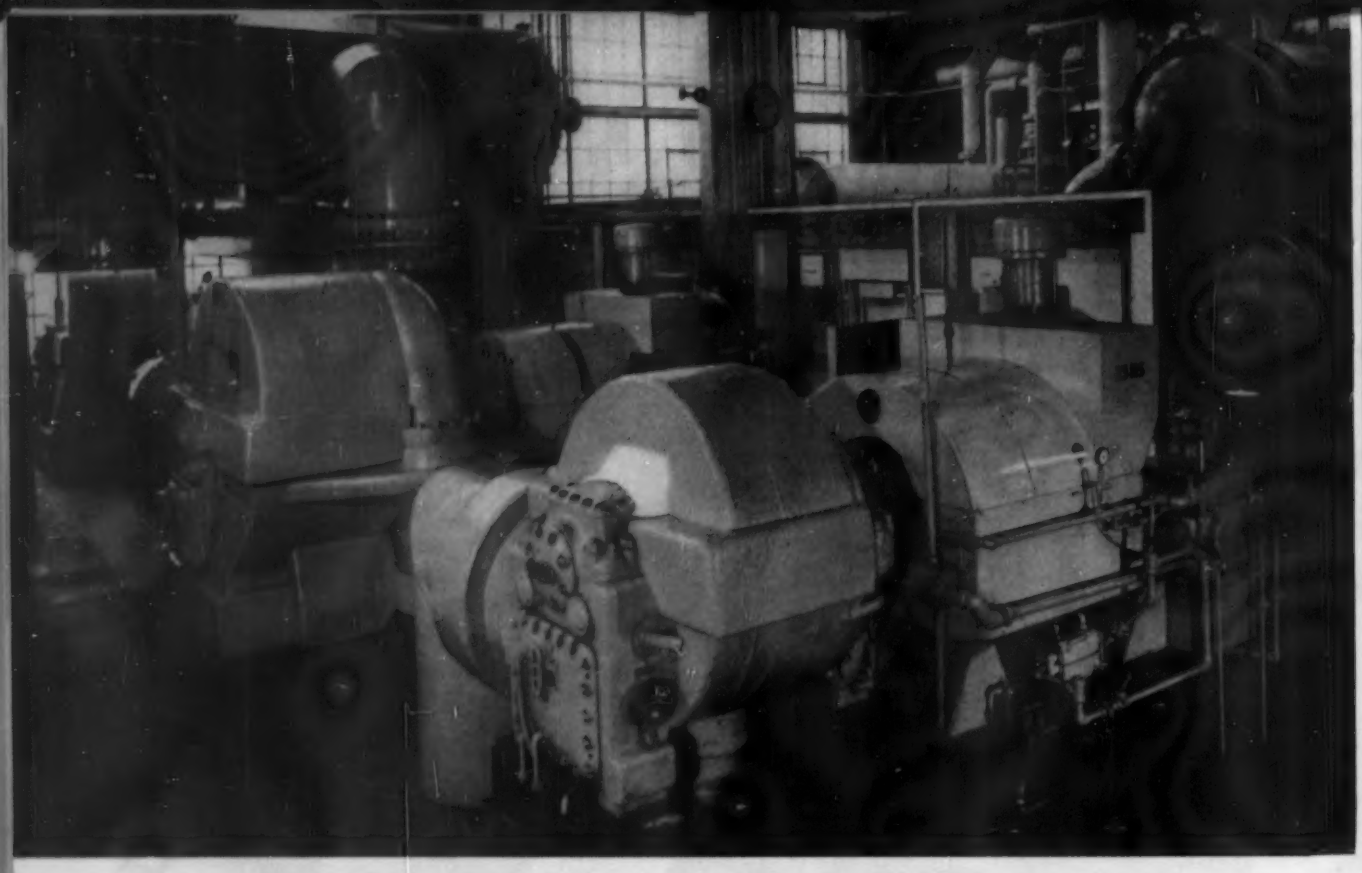
inside this valve and see how it works

plant. Then pilot can be cleaned in leisure time, placed back on shelf.

Operating cycle. Main valve is normally closed. Placed in service, pressure acts on under side of small pilot valve. Control line then connects pilot diaphragm chamber to delivery piping. Now compressed adjusting-spring forces pilot valve open, see details in drawing.

Connecting tubing conducts fluid from pilot to main valve diaphragm and bleed port. When pilot opens, fluid flows through pilot faster than it can escape at bleed port, creating a loading pressure that forces main valve open.

Delivery pipe and control line are now being filled with fluid flowing through main valve. As delivery pressure rises, it overcomes force exerted by adjusting spring and pilot throttles. This, in turn, allows main valve to throttle just enough to maintain the set delivery pressure. When demand stops, pilot closes, allowing main valve to close. *Courtesy: Spence Engineering Co, Inc, Walden, New York.*



Refrigeration—many thousands of tons—plays a stellar role in our process at Eastman Kodak. Here's . . .

How we overhaul one of our big turbine-driven centrifugals

► Refrigeration is a key power service at Kodak Park. Total tonnage is way up in the thousands and the plant includes a wide range of compressor sizes. We control temperature at five different levels—minus 85 F, minus 36 F, 9 F, 35 F and 40 F.

But in a plant as complex as ours refrigeration means more than just maintaining a couple of compressors and a heat exchanger or two. We're responsible for keeping six reciprocating ammonia compressors and 17 centrifugal Freon units in top shape. And the plant includes a host of other power-service equipment and functions—steam-turbine drives, motors, steam and refrigeration condensers, instruments and controls, pumps, cooling towers, water treating, lubrication, etc. The cold-brine and chilled-water distribution systems fan out, in big, cork-covered lines, to 36 different buildings throughout Kodak Park.

Load demand consists of large amounts of circulated air in work areas where we sensitize, process and handle photographic film and papers. We also maintain low temperatures in storage rooms and for a wide variety of other processes.

Big maintenance jobs are scheduled for winter months, keeping our equipment available to meet summer peaks. Exceptions are minus 36-F and minus 85-F systems handling relatively constant process loads.

To manufacturing departments, most important item is service continuity, so our maintenance schedule is set up to keep interference with production to a minimum. Table, facing page, shows maintenance needs and frequency for major equipment.

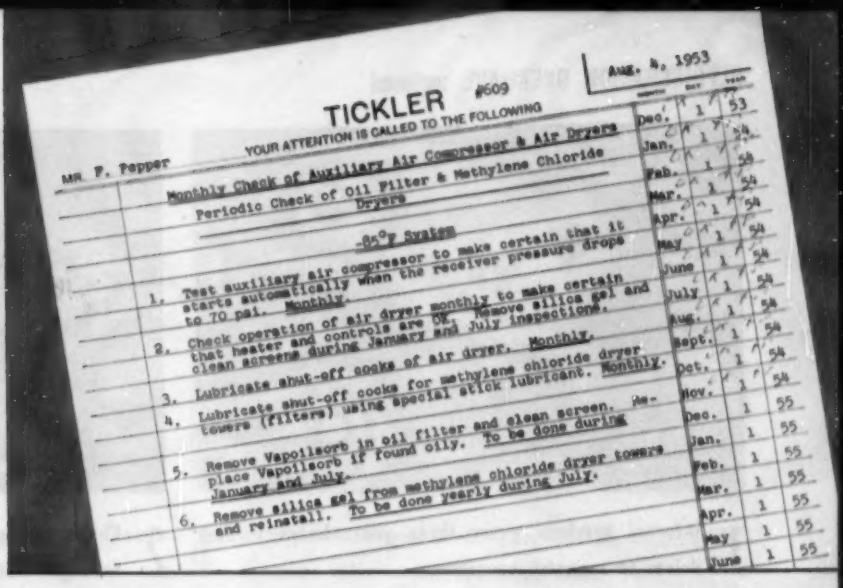
Yearly overhaul schedule for main units keeps maintenance and production men fully informed, coordinates their jobs. A work sheet spells out maintenance work needed, internal or external overhaul, etc, depending on equipment's condition.

Units that don't need work sheets and items we might overlook are followed up by a tickler system, see sample form, facing page, with a master file in the operating office. Each staff supervisor keeps copies of ticklers he is re-

Here is firsthand info on how one of world's biggest refrigeration plants maintains . . .

- **Steam-turbine drives**
- **Refrigeration compressors**
- **Steam condensers**
- **Refrigeration condensers**
- **Instruments and controls**
- **Pumps**
- **Cooling towers**
- **Water treating**
- **Lubrication**

By **L C ENGELHART**, *Supervisor, Refrigeration & Water Dept, Eastman Kodak Company*



TICKLER #609

AUG. 4, 1953

MR P. Pepper — YOUR ATTENTION IS CALLED TO THE FOLLOWING

Monthly Check of Auxiliary Air Compressor & Air Dryers

Periodic Check of Oil Filter & Methylene Chloride Dryers

-80°F System

1. Test auxiliary air compressor to make certain that it starts automatically when the receiver pressure drops to 70 psi. Monthly.
2. Check operation of air dryer monthly to make certain that heater and controls are OK. Remove silica gel and clean screens during January and July inspections.
3. Lubricate shut-off cocks of air dryer. Monthly.
4. Lubricate shut-off cocks for methylene chloride dryer towers (filters) using special stick lubricant. Monthly.
5. Remove Vapoilsorb in oil filter and clean screen. Replace Vapoilsorb if found oily. To be done during January and July.
6. Remove silica gel from methylene chloride dryer towers and reinstall. To be done yearly during July.

	DAY	YEAR
Dec.	1	53
Jan.	1	54
Feb.	1	54
Mar.	1	54
Apr.	1	54
May	1	54
June	1	54
July	1	54
Aug.	1	54
Sept.	1	54
Oct.	1	54
Nov.	1	54
Dec.	1	55
Jan.	1	55
Feb.	1	55
Mar.	1	55
Apr.	1	55
May	1	55
June	1	55

TICKLER FILE keeps maintenance men posted on jobs that might be overlooked

Maintenance schedule for Kodak Park's major refrigeration equipment

Item	*Maintenance frequency*	*Remarks*
Reciprocating compressors	8000-hr operation	Dismantled inspection recommended by insurance company
	1 to 3 years	Reflectoscope inspection for crankshaft cracks
Turbine drives for centrifugal compressors	1 year	External overhaul
	3 years	Internal overhaul
	3 months	Overspeed trip check, recommended by insurance company
Centrifugal compressors, refrigeration unit	1 year	External overhaul
	As needed	Compressor cover raised if unit vibrates, shows operating trouble
Brine and water pumps	6 months	Inspect during operation. Overhaul if needed, or at 25,000-hr operation
Instruments, controls	1 year	With unit overhaul
Safety controls	3 months	Includes turbine overspeed trips
Cooling towers	6 months	Inspection, with repair as needed
Freon leaks	2 weeks	Inspection with electronic leak detector
Lubrication	Listed on Kodak's detailed chart	
Methylene-chloride brine drying	1 month	Monthly brine sample. Unit de-iced as required
Brine treatment	2 months	Inventory, specific gravity and pH test
Relief valves:		
Ammonia compressor	1 year, with overhaul	Hydraulic test for leaks and reset if needed
Other ammonia	5 years	
Freon	1 year, with overhaul	

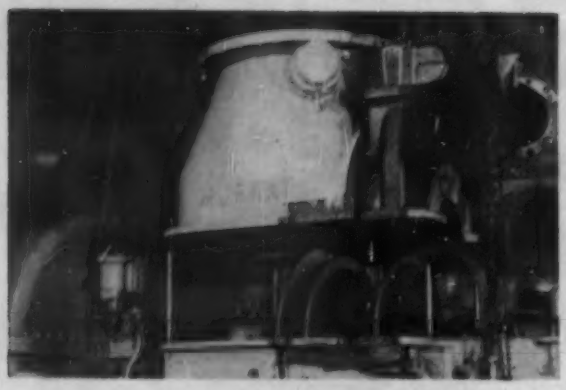
sponsible for, follows them up and makes a permanent record of them.

Twice-a-year plant inspection and monthly housekeeping inspection pick up any loopholes in our work sheet and tickler system.

Spare parts, a key item in any good maintenance program, are stocked on the basis of our own experience and manufacturer's recommendations. Result: We get many an emergency repair job done in a hurry, avoid work repetition on planned overhauls where we find worn parts.

To see how our setup actually works out, come along on an internal overhaul—one of our 800-ton centrifugal machines using Freon-11, operating on the 35-F chilled-water system.

Let's start by overhauling steam-turbine drive ►



1 Internal overhaul every three years keeps turbine drives in topnotch condition

Remove the turbine-drive casing every three years. Frequency is based on our own experience, manufacturer's recommendations and insurance company's advice.

For his records, insurance inspector examines internal parts for cracks, erosion, steam deposits and shaft wear.

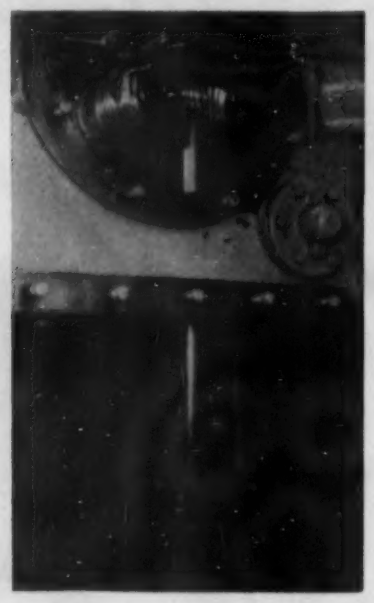
Dial indicator at end of shaft measures thrust clearance when we force shaft axially against thrust shoes. Clearance between steam nozzle and wheel is checked at the same time, with a feeler gage to make sure it's right.

2 Check turbine thrust and main bearings accurately for right clearance

Pull dead-soft pure-lead wire down under the main bearing cap of the turbine to measure clearance here.

Remove carbon packing to inspect main shaft. Check

Excessive vibration, capacity drop-off signal compressor trouble



5 Heart of compressor oiling system is the oil pump

6 Float valve returns excess oil from seal end of compressor

After inspecting compressor's main oil pump and gear drive for wear, examine all compressor parts except the rotor and internal passages, through cover plates on the outside. Compressor cover isn't pulled off unless a warning signal—vibration or capacity drop-off—shows up. Refrigerant doesn't normally deteriorate so we feel that removing the cover disturbs the unit needlessly, wastes valuable time.

On the compressor's outboard end, inspect the main and thrust bearings using same technique shown for turbine bearings. At inboard end, shaft seal and main bearing are checked.

Main items to look for on float valve, which returns oil from compressor's seal

3 **Adjust carbon-ring packing fit to prevent leakage, excess wear. Also inspect main shaft**

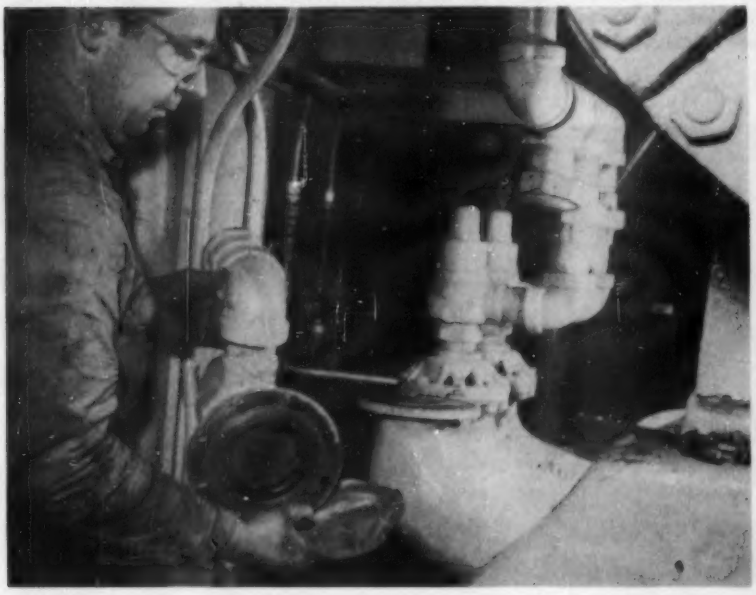
4 **Good turbine-speed control depends on keeping the governor valve in top operating shape**

shaft for cutting from condensate or from rubbing rings. A close look at turbine casing spots erosion due to moisture thrown from the bucket wheels.

Another key item: Check alignment of steam turbine and refrigeration compressor at the flexible coupling.

Dismantle governor valves. Clean and check, for wear, oil-operating cylinders, pilot valves, and seats and stems of steam valves. Care here saves many a headache later.

To complete turbine-drive overhaul, examine auxiliary and main oil pumps, clean and refill oiling system, and check turbine oil cooler with service-water pressure to make sure no cooling water leaks to oil side, contaminating oil.



Steam and refrigerant condensers need to be cleaned, checked for leaking tubes - - - - ►

7 **Reliable bursting disks backed up by correctly set safety valves release refrigerant pressure in emergency**

end, are wear and tightness. A leak here allows air to enter system, causing capacity loss, high compressor-discharge pressure and excessive air-purge-unit operation—a situation that will soon lead to even worse headaches.

Next, test compressor oil-cooling coils with service-water pressure for several hours to detect possible leaks. Compressor oiling system is also cleaned, refilled and given an operating check.

Remove and inspect bursting disks. And don't hesitate to replace those in poor condition. Backing up disk with relief valve keeps refrigerant loss to minimum if disk should break.

Hydraulic test makes sure you have right relief-valve setting, protects unit.

8 Clean condenser tubes keep condensing pressure low, save power, boost efficiency

Open steam-condenser, refrigerant-condenser and cooler waterboxes to spot scale and plugged tubes.

If tubes are dirty, acid cleaning is one good answer. Connect a portable mixing tank and pump to the waterbox. Recirculate muriatic-acid solution, 5% by volume, with an inhibitor, for two or more hours, depending on tube condition. Remove acid solution and flush tubes thoroughly with neutralizer and water to keep acid from attacking tubes.

9 Cooling water to 35 F demands accurate protective controls to prevent freeze-up

With outlet chilled-water temperature at 35 F, and temperatures as low as 28 F on the refrigerant side of the cooler tubes, low-temperature cutouts must be accurate to shut down unit and prevent freeze-up in an emergency. Primary elements measuring these temperatures are spotted strategically to insure correct lowest temperature sensing.

Tickler system acts as a reminder for regular testing of instruments and controls

12 Test pressure gages with dead-weight tester. All instruments are checked yearly during regular overhaul periods

Accurate instruments and controls are vital to economical and safe equipment operation. To make sure instruments always give accurate readings, routine ticklers act as reminders for regular instrument-testing jobs, also serve to record any maintenance work done.

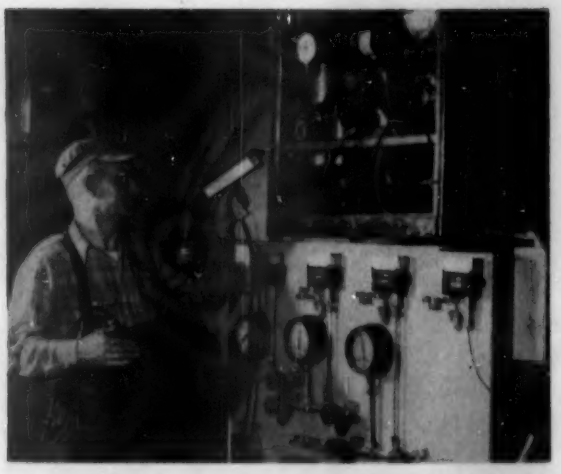
Maintenance schedule, bottom p 115, calls for yearly check on instruments and controls during machine overhaul. Items tested during overhaul include pressure gages, thermometers, flow recorders, controllers, pressure and temperature switches.

Using latest testing techniques recommended by manufacturers keeps instruments in top condition, gives us accurate performance data.

10 Check purge unit's operating efficiency in removing air, water from refrigerant

Waterbox primary element is on reinforcing unit of baffle and is right in front of tube outlet from last pass of cooler.

If purge-recovery unit was collecting too much water before overhaul, check refrigerant condenser and cooler tubes for leaks. You can do this by raising refrigerant pressure and testing with an electronic Freon leak detector while heads are open. Repair or replace leaking tubes where necessary.



11 Electronic Freon leak detector spots refrigerant leaks in a hurry, simplifies trouble shooting

Spotting a leaking tube is easy with the electronic leak detector. Test turbine and steam condenser in same way as refrigerant condenser by allowing a small amount of Freon gas to enter steam space. Then raise pressure to about three pounds with compressed air, and turn on gland-sealing steam to prevent leakage at shaft. Use Freon leak detector where air might leak into the steam space.

13 Constant-temperature bath, with test thermometer, accurately checks temperature-control elements

Testing temperature-control element in a constant temperature bath against a test thermometer is sure way to keep primary sensing elements accurate. Important part of this job is calibrating recording pen and checking point at which safety switch makes contact.

Kardex file lists all the instruments. If you make adjustments or do work, list exactly what you did on file card for the instrument. This gives you a running picture of instrument reliability, spots those needing replacement.

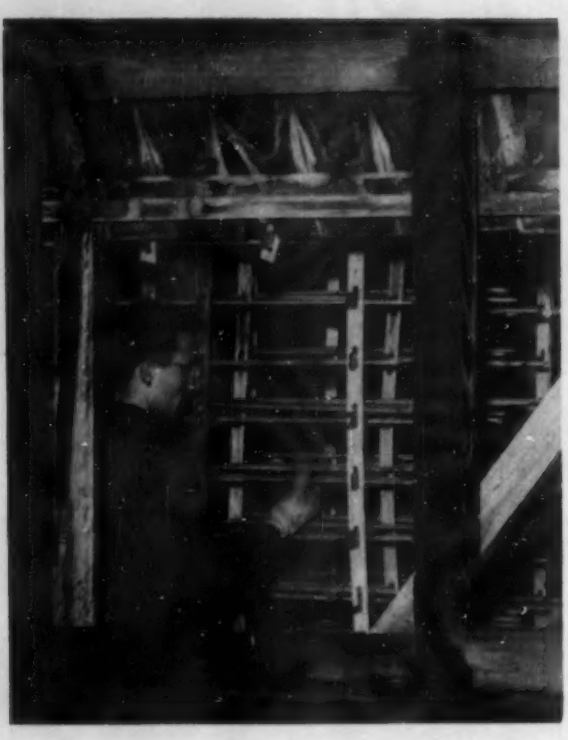
14 Stroboscope measures rpm at which turbine emergency overspeed trip cuts out machine

Test all safety cutout and alarm features every three months—including stroboscopic check of overspeed trip on the turbine, uncoupled from the compressor, above.

Inspect flowmeter integrators monthly to make sure that figures for refrigeration output are correct.

Six-month inspection, during operation, of water and brine pumps keeps these units in topnotch condition. Overhaul pumps after about 25,000 operating hours.

Next comes the cooling tower ►



15 **Inspect cooling-tower i-d fan rings, drives, mountings for excessive wear and looseness. Cooling-tower fill must be in good condition to get maximum cooling effect**

Take a close look at cooling towers every six months. Drain oil from fan gear reducers. If oil condition shows internal wear, open the gear reducer for repair. Otherwise, only change oil. Also, examine fans, fan rings, drives and mountings for wear, looseness.

Careful inspection of main-cooling-tower structure and its fill shows up possible deterioration due to condensing water. Don't forget to see whether nozzles and distribution piping are clogged with scale and wood splinters.

Water treatment. Lab technicians are responsible for chemical control of condensing water, chilled water and calcium-chloride brine. They treat condensing water for algae control with 1-ppm chlorine by manually adjusted feed equipment.

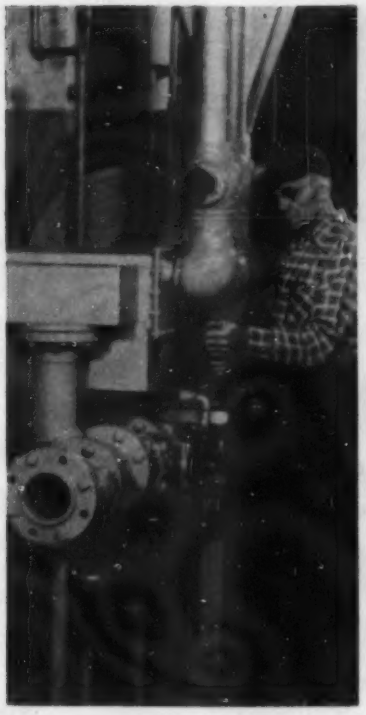
Other key operations in treating water are: (1) Prevent scaling by treating condensing water with two to five ppm concentration of neutralized sodium phosphate. (2) Measure its solids concentration daily and set blowdown to hold 100-ppm chlorides. (3) Treat chilled-water for slime with about 150-ppm concentration of sodium pentachlorophenate and control turbidity to about 40 ppm—as measured by the Hellige turbidimeter. (4) Treat calcium-chloride brine with sodium bichromate to prevent corrosion as you add new brine to the system for makeup. (5) Add caustic to calcium-chloride-brine system, as needed to keep pH at about 7.5. Surface fouling in calcium-chloride-brine systems isn't a problem, so coolers aren't opened for cleaning.

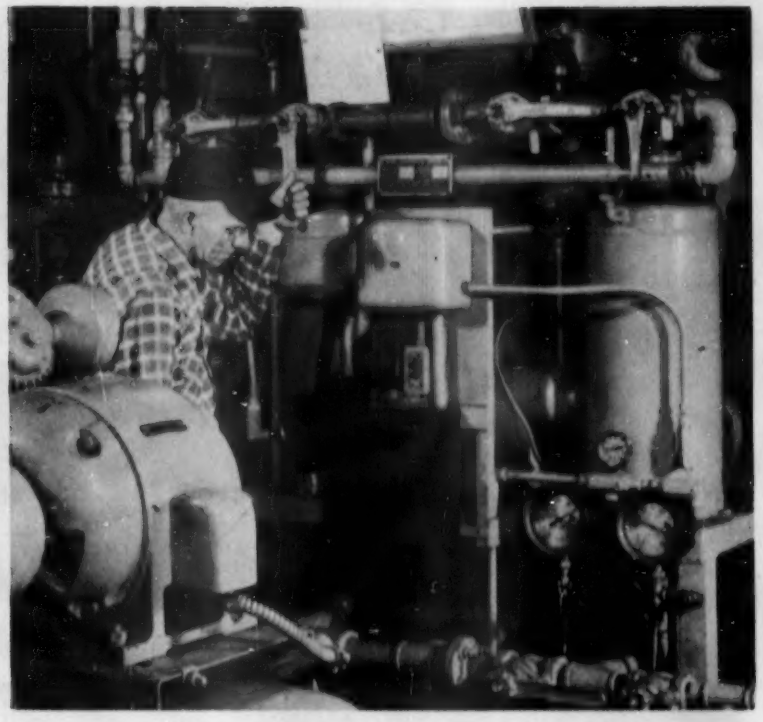
Refrigeration distribution. Check distribution lines every fall, to see if cork covering, hangers and supports need repairs. Also, examine weather protection over cork. Actual work is done the following spring, when weather conditions are better.

Right lubrication gives extra operating years, minimizes wear. Operators have a chart listing all equipment needing lubrication, lubricant type and frequency, and man responsible for lubrication.

Some turbine drives are set up for continuous overflow oil centrifuging, where it can be done with a common centrifuge. Other turbine-oil supplies are dumped and centrifuged during overhaul. Take monthly oil samples from all compressors and main turbine drives, to check on corrosive conditions, water or dirt contamination, and lubricating quality.

Careful treating of condensing water, chilled water and brines keeps equipment in topnotch condition





16 Put methylene-chloride brine in −85 F units, through dryer

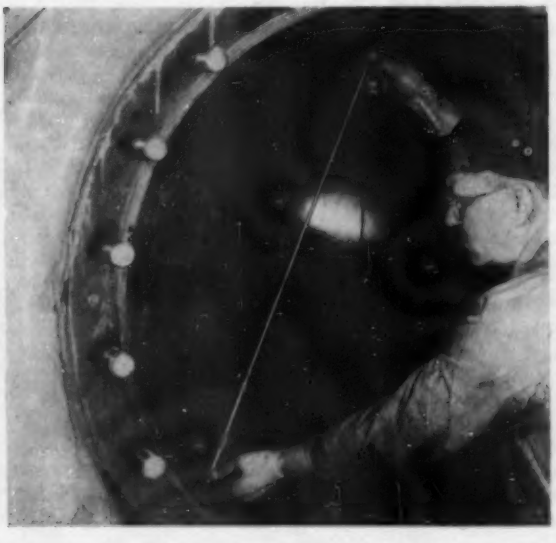
Ever-present problem, in the minus 85-F methylene-chloride-brine system is small quantity of water that collects as ice on inside of brine cooler tubes—cutting down unit capacity. When this happens de-ice system and recirculate brine through silica-gel drying unit. This drying method holds moisture content of 200,000-gallon brine system to less than 0.01%.

Oil, on refrigerant side, also contributes to capacity drop-off. Purge oil while de-icing the unit.

17 Air for sealing methylene-chloride-brine balance tank is dried, to keep moisture from entering refrigeration system

For a sealed and moisture-free brine system, keep the balance or expansion tank under air pressure with dry air. Special silica-gel dryer supplies this air from regular plant 80-psig air system.

Take monthly samples from brine system to figure specific gravity, moisture content and acidity.



18 Measure ammonia-compressor cylinders for wear. Rotate pistons if needed

In spite of its efficiency as a refrigerant, ammonia is gradually giving way to the Freons. Two main reasons: Freons are (1) more adaptable to centrifugal machines (2) much less difficult to handle.

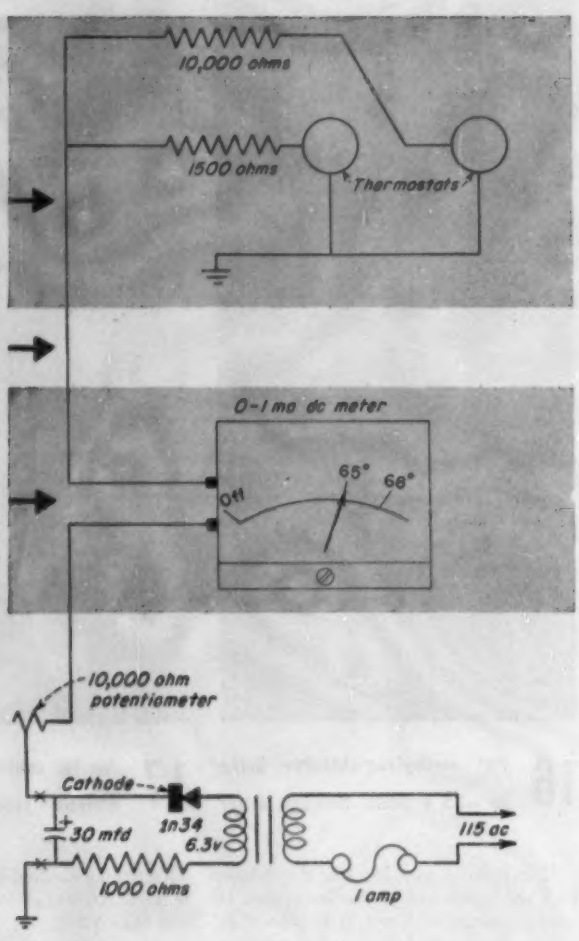
But maintaining the ammonia system is an important job and the reciprocating compressor calls for close supervision.

Dismantle reciprocating units every 8000 operating hours for inspection. Clean oil piping and passages. Check for cracks with whitewash, and measure cylinders, pistons and bearings for wear, left. Rotate pistons, if needed, to avoid uneven wear. Examine compressor suction and discharge valves along with shutoff valves, for poor seating. Every one to three years, check main shaft with a reflectoscope to show up possible cracks.

Ammonia intercoolers and condensers are vertical, open type. Clean these by turbining once a year, each spring, to remove scale. As high-load season comes along repeat turbining to keep surfaces clean, reduce condensing pressure.

Temperature checked over a single wire to control panel at a cost of $25

By L W FITZPATRICK, *Chief Engineer, Dept of Corrections, Jefferson City, Mo.*



► TELEMETERING SYSTEMS are sound investments for indicating steam-power output and pressures in most large plants. Commercially available equipment is on tap that can be had from many telemetering manufacturers. But there are many spots in the smaller plants that may not warrant a full-scale telemetering installation, yet still require remote supervision.

Recovered steam in our setup, both flash and exhaust, is dumped into a distribution line to heat a large greenhouse about a half mile from our power plant. Because the greenhouse, heated by temperature-controlled unit heaters, has many valuable flowers and plants, we need a visual temperature indicator back in the power plant.

We made the simple hookup above for less than $25, excluding wire cost. We saved the wiring charge by swinging over to one wire of our regular telephone circuits and using out water-distribution system as ground return.

Materials used. Indicating instrument is a dc meter, 4½ in., 0-1 ma, mounted on the main control panel in the power plant. The power supply is mounted on a 3x5 in. masonite base, fastened directly to the meter studs. Standard 6-v battery can be used since current drain is small. Battery would hook in at points *X* in sketch.

Regular thermostats, set at 65 and 68 deg, are in the greenhouse. When either closes, the resistor network instantly transmits the corresponding temperature reading to the control panel. We made a paste-up scale to show these temperature differentials with the 65-deg mark beyond ½ scale and the 68-deg point at about ¾ scale.

If we wanted, closer indication could be had by using another thermostat and a 27,000-ohm resistor in parallel with the thermostat resistors shown. This thermostat would correspond to ¼ scale, setting the others at ½ and ¾.

We found it best to install resistors right in the thermostat cases using standard radio-type 1-watt units. Commercial resistor tolerances do not cause an appreciable error. The 10,000-ohm wire-wound potentiometer compensates for transmission-line resistance. It is set initially to keep the meter needle from overshooting end of the meter scale.

Pressure changes could be indicated with a similar setup if pressure switches were substituted for thermostats. In such a hookup, note the pressure range of the switches selected as well as the differentials.

ED NOTE: *With a little imagination the above scheme can be used for many remote indications in the plant. Typical variation would be identifying conductors in a cable where a helper wasn't on hand. Here individual resistors connect to cable conductors at one end with the milliammeter or ohmmeter at other end of cable.*

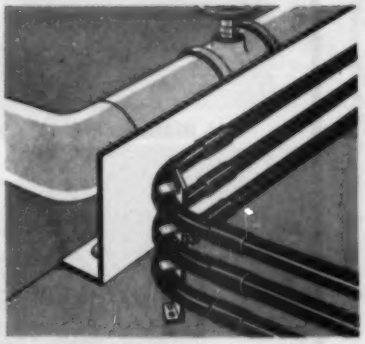
If two or more wires are available between remote point and control panel, individual lamps can be substituted for the panel meter. Corresponding temperatures marked near each lamp.

8 tips on stretching cable life

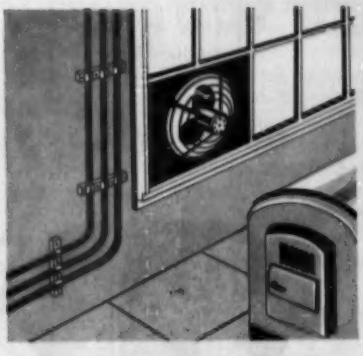
These practical time - proven kinks may add years to your plant feeders by protecting cable insulation.

They are but a few of many tips. Example: Splicing skill and care is major factor.

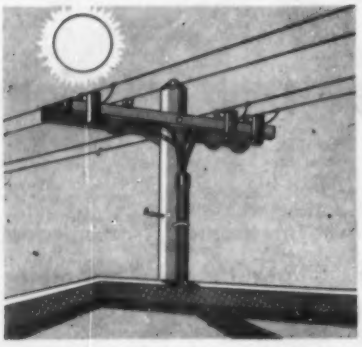
Data from The Okonite Co



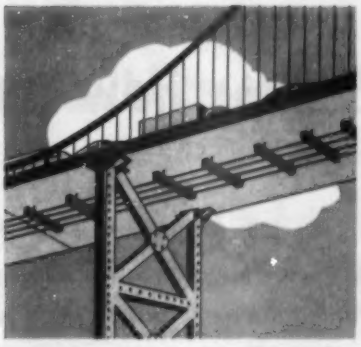
1 **Near hot pipes,** heating units, move wiring or insert baffles between hot lines and cables to deflect air



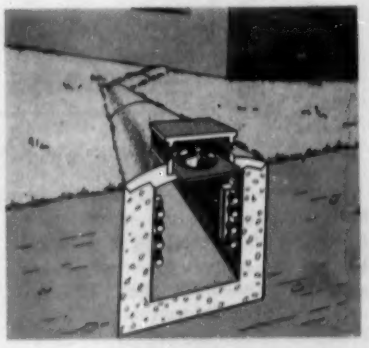
2 **Hot locations** may call for vents in ceiling or partition above cables. Consider fan for better air flow



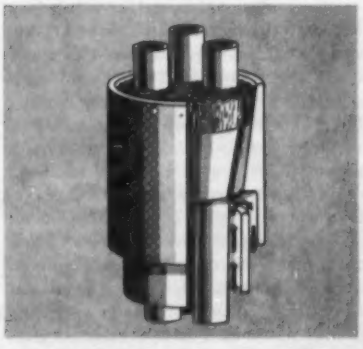
3 **Northern exposure** best for riser conduits. Keep cable conduits on shaded side of pole for top cable life



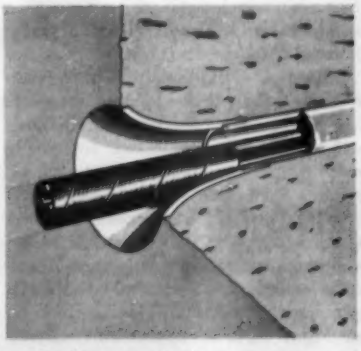
4 **Protect runs** on viaducts by placing cables on structure's under side. Sun, weather, mechanical damage reduced



5 **Tunnel job** is vented by grilles or blower. Prevent hot spots by having adequate venting all through tunnel



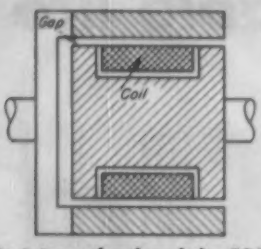
6 **Ventilate** riser conduits with top opening or by leaving space between conduit and pothead for air flow



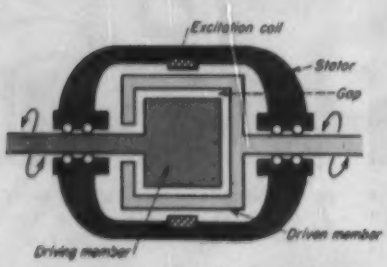
7 **Cable wrapping** at openings protects cables from abrasion. Extend arcproofing wrapping back into duct

8 **Store cables** in cool place. Cable insulation remains in best condition if temperature extremes are avoided

CLUTCH

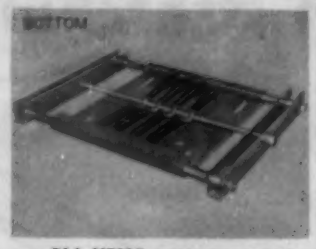


Prototype developed in 1948

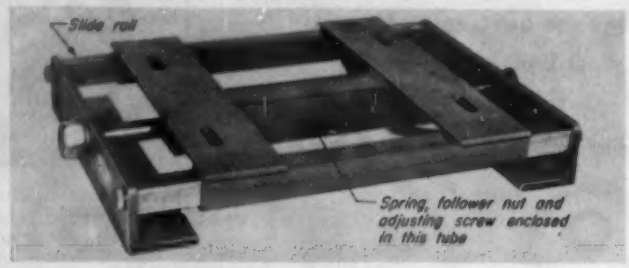


Magnetic particle clutch of today

MOTOR BASE



Old NEMA motors mount on base with tension springs



New base for rerated motors has compression spring

PROGRESS REPORT: How three transmission

In the last few years, two of these mechanical transmission elements have undergone design changes, the third has maintained the same basic design while broadening out its applications. Here's your report on how they have developed

► SINCE their last presentation to POWER readers, the magnetic-particle clutch, the spring-tension motor base and the toothed "timing" belt have undergone some interesting changes.

Clutch. The magnetic-fluid engaged clutch, introduced to POWER readers in June 1949, has evolved into the magnetic-particle clutch. Vickers Electric Division is a major producer of this unit. Here's what they have done:

As originally developed by the National Bureau of Standards, the magnetic-fluid engaged clutch transmitted power through a fluid consisting of fine iron powder mixed with oil. Fluid was placed between two movable members. Energizing electric coil engaged clutch.

When Vickers began to develop this clutch, they found it inherently difficult to prevent oil leakage along the rotating shaft. The prototype generated heat during operation, then oil expanded. But oil was in an enclosed space, so expansion created high pressures. Some oil and ferrous material leaked out.

Eliminating the oil solved the problem. The redesigned product is known as a magnetic-particle clutch (sketch).

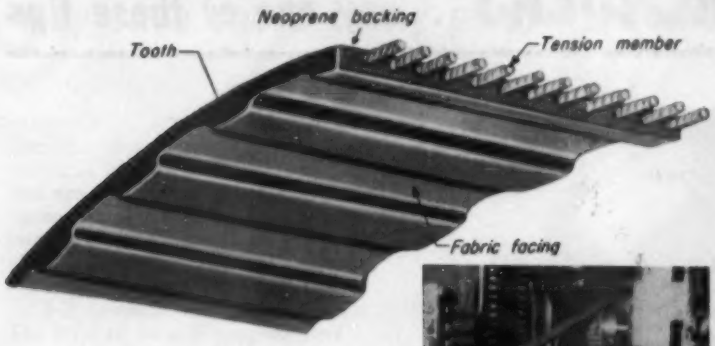
Here's how it operates: Gap between driving and driven members contains finely divided ferromagnetic particles. Energizing the stator coil produces a magnetic field. Radial lines of magnetic force develop, and the particles within the gap cling to each other, forming chains along the lines of magnetic force. The chains create a bond between driving and driven members. Increasing control current increases the shear resistance, and thus the bonding strength.

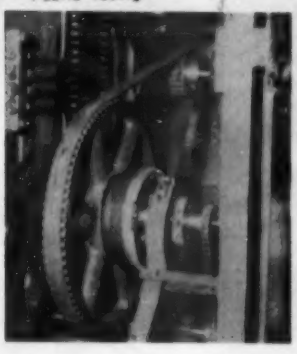
When torque load exceeds shear resistance, the particle chains break and clutch slips. Degree of magnetic-particle bonding is proportional to the energizing current, so torque transmission, or torque limit, is regulated by varying the exciting current.

For any given current, the clutch transmits constant torque, and is essentially a constant-speed drive. But torque transmitted is independent of the relative rotational speed between driving and driven member. When input and output speeds are not the same, clutch slips, and heat generated must be dissipated. This becomes a limiting factor and must always be considered in the design, especially where there is repetitive starting of a high-inertia load.

Here are advantages and disadvantages, according to W G Martin III, of Vickers Electric Division: (1) Clutch and brake action are extremely smooth, thus avoiding shock. There is no mechanical connection between torque-producing surfaces so operation is quiet. (2) Torque-producing surfaces and magnetic medium do not wear measurably. Need for clutch surface mainte-

BELT





Construction of this belt with teeth has not changed since 1952. Photo at right shows drive for a wire-twisting machine

elements meet today's needs

nance is cut out (life of replaceable bearings determines life of unit). (3) Remote control is easily possible; relatively small amounts of coil power control torque. (4) In general, magnetic-particle devices are larger for a given torque rating than mechanical clutches, but smaller than certain other magnetic-type clutches. (5) For a given size, heat-dissipating ability of a magnetic-particle clutch may be less than that of a mechanical clutch because air gap must be enclosed.

Motor bases. Rerated motors pack more power into the same frame size. Motor base must cope with increased weight and reaction forces. Jan 1952 POWER, p 118, gives operating theory.

If the unit is direct-coupled, rigidly mounted, or mounted on manually adjusted slide rails, the only problem in replacing an old motor with a rerated unit is to keep the distance from shaft center to base the same, and to avoid disturbing the original fastening-bolt location. This can be taken care of with a "transition" motor base available from motor manufacturers.

But where the motor is connected to the driven machine through belts, and an automatic self-adjusting base is employed, the additional weight and reaction forces pose a problem.

In a statement for POWER, J J Sloyan of the Automatic Motor Base Co gave this information on how spring-tension motor bases are meeting the situation:

Automatic Motor Base Co manufactures light-duty bases in several sizes for motors up to 15 hp, and heavy-duty bases for motors up to 500 hp. Both types use springs to control belt tension, absorb shock loads and compensate for belt stretch.

The light-duty base for old NEMA ratings uses springs in tension, and motor carriage slides on rails during operation. Heavy-duty base employs springs in compression; motor carriage slides back and forth on ball-bearings.

Rerated motors put about twice the horsepower into the same outside dimensions. For instance, an old NEMA No. 254 frame delivers 5 hp at 1800 rpm. The new NEMA No. 256U, which would mount on the same motor base, delivers 10 hp at 1800 rpm. The additional weight and reaction force would be too much for the old light-duty base for the 254 frame to handle.

So Automatic Co designed a new base with compression springs to take care of the added motor reaction and square steel tubes riding on solid slide rails to provide the necessary mounting rigidity. This base, in various sizes, handles both old and new frames. Characteristics are the same as for the bases for old NEMA motors, but capacity and appearance have changed. A modification, without the compression spring, but with a crank handle, permits mounting motors with variable pitch pulleys.

The heavy-duty bases for higher-hp motors are essentially unchanged.

Belt. The toothed "timing" belt introduced to POWER readers back in August 1952 has developed from a novelty in belt transmission to the point where stock drives are readily available.

Construction hasn't changed materially, according to R J Higham, chief timing-belt engineer with U.S. Rubber Co, and New York Belting and Packing Co, producers of the belt. Essentially, this is a flat belt with teeth equally spaced on the surface, (photo).

Teeth mesh with axially grooved pulleys. The load-carrying tension member is wound and molded in a thin layer of neoprene. It is made of cabled-steel wire for ordinary applications; it may be cotton cord for light duty. Neoprene backing protects the tension member from dirt, heat, moisture and friction.

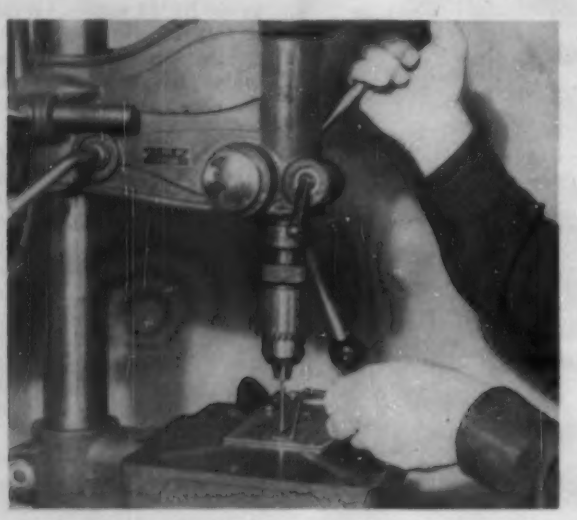
Teeth are molded integrally with the neoprene encasing the tension member. Pitch line is neutral plane in the tension member that separates tension and compression zones when belt is flexed. Construction keeps pitch of the belt constant so it meshes properly with the pulleys. In operation, you can think of a timing belt and pulley as being similar to an internal gear and pinion.

Pulleys for average drives are steel or cast iron. For light duty, aluminum, plastic, laminated phenolic and die casting are sometimes used.

Besides the standard belt, there are three special constructions for (1) explosive atmospheres (2) low temperatures (3) heavy oil conditions. Speeds up to 16,000 fpm and down to inches per minute have been used, but the normal range is from 1500-5000 fpm.

Here are some applications where timing belts replaced other belts or chains: *Snag grinder:* Three *Gilmer* timing belts drive unit that grinds 6000 automotive transmission cases a day. Unit is driven by a 40-hp motor, through 4-in.-wide belts. *Exhaust blower:* 8-in.-wide belt running over 7-in.-dia driver pulley drives 185-hp unit. *Wire-twisting machine:* 3-hp motor running at 1800 rpm drives unit through a 1-in.-wide belt. *Truck-mounted concrete mixer:* 3½-in.-wide belt, 66 in. long transmits 54 hp, drives mixing drum at 300 to 600 rpm.

PRACTICAL IDEAS ... *any one of these tips*

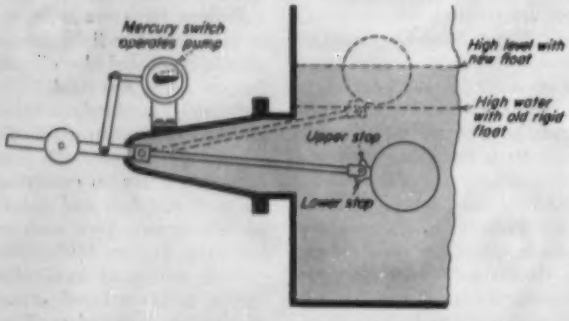


Punch soft sheets—don't drill them

DRILLING HOLES in copper or aluminum sheet metal is often a problem because these materials have a tendency to tear. You can make cleaner holes by punching. And your drill press is easy to rig into a punch press. Just clamp a plate of cold-rolled steel to the drill-press table with C clamps, photo.

Next, drill a hole through the plate of the size needed in sheet material. Plate is now a die. Remove drill from chuck, grind shank-end square and chuck it again, with cutting lips up inside chuck. Drill now serves as a punch for any light material, including thin plastic most of us work with.

E ROBBERSON
Port Washington, N. Y.



Now, float gives us wider control

WE CHANGED controlled water-level in a flash tank, sketch. Float turned on pump when water reached the upper level, shut it off when water was lowered. As float assembly is integral part of tank, we couldn't raise complete float assembly.

We also fastened float to rod with hinged joint. This allows float to pivot at rod's end, increases range of controlled water-level. Stops must be used at hinged joint to keep float from swinging too far under or over float rod. Hinged joint should allow float to pivot freely. By positioning stops and lengthening rod between pivot and float, a wider range of high and low water is controlled. You must adjust external counterweight to give correct operation.

C TRETINYAK *Rochester, Minn.*

25 compressor commandments

LOCATE COMPRESSOR at least one foot from wall or any obstruction. Then air can circulate about it. This helps prevent unit from heating. On large units be sure to have enough space for removing pistons, piston rods, etc.

Your compressor must be level and lagged to floor with flywheel end pointing toward a wall, if possible. Size of machine depends on type of foundation needed. If unit is near an office be sure machine supports absorb vibration.

Long lines cause pressure drop so locate unit near operation. Make piping large enough to carry intended load. Locate compressor in room where it has supply of clean, cool, dry air. If needed, connect air intake to outside of building. Have distance between intake and compressor as short as possible for efficiency. Protect outside intake from elements with cover. Reduce maintenance by placing compressor where it can be easily serviced.

A competent electrician must do wiring according to National Electrical Code. Make sure motor has same voltage and frequency as power line. Correct type of wire with full power supply assures enough current during starting of other peak loads.

Check belt tension and alignment for proper power transmission. When replacing belts, use a matched set. Remove dust from cooling fins, including intercooler and aftercooler.

Check and clean air-intake strainer at least once a week. Make sure all compressors have strainers. Clogged air strainer causes compressor to operate longer than needed. It also causes compressor to pump oil and heat up.

Have flywheel tight on crankshaft, or compressor will knock. For good operation, check safety valves periodically. Install these valves on intercooler, aftercooler and receiver. You must have one safety on the discharge line between compressor and any shutoff valve in line.

On watercooled units, a supply of cool water must flow continuously through water jacket of air cylinder while compressor is operating.

Keep a constant level of good, clean oil in crankcase at all times. Inspect bearings occasionally, keep them properly adjusted, don't let a bearing pound. Keep all bolts tight.

Drain receivers regularly as an oil

may save you a costly plant headache

STEVE ELONKA, *Associate Editor*

accumulation may cause oil vapor to explode. Automatic way to drain receiver is to install a trap.

Lubricate compressor according to manufacturer's instructions. It's best when installing large compressors to use manufacturer's services or competent erectors.

B A CROSSON *Cranston, R. I.*

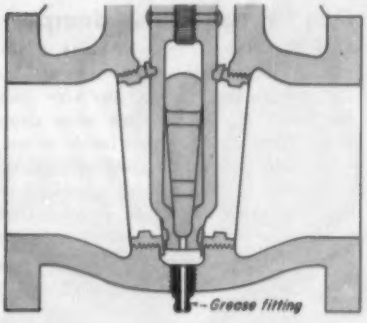
Don't cut diesel lube-oil too much

CAMACHO SAYS, March, p 137, he reduced oil consumption in diesel engines by increasing efficiency of his scraper's rings. Readers should know that oil consumption of one gallon per 1500 bhphr is about the optimum.

Any further reduction results in excessive wear. I have seen a few sad cases from reduced consumption beyond this figure, with "patent" scraper rings. Jobs wound up with heavy repair bills after only a few hundred hours of "economical" running.

P D HOBSON *State College, Pa.*

EDITOR'S NOTE: *Readers, what's your experience on this problem?*



Did you ever try this?

CHECK VALVE on our gas pump had to be repaired. Gate stop-valve leading to discharge header was under pressure of only 15 psi, and yet it wouldn't hold.

We drilled bottom of gate valve, sketch, for ⅛-in. pipe tap. Then we screwed in button-type grease fitting. Grease was pumped in with valve cracked open slightly. Then we closed valve while forcing in more grease. It worked, and leak stopped completely. I've learned that valve, or any sealing surface, that's tight against a liquid may not seal a gas. Since gases have no surface tension you must have a perfect mechanical surface.

F J ARDOLINO *Brooklyn, N. Y.*

What would you have done?

A HOPPER BOTTOM, funneling dry sand into an elevator that handled large tonnages, kept wearing through its steel sheets every three weeks. System had to work around clock, seven days every week. So engineer had to keep system working.

He tried thicker steel sheets, harder sheets, rubber linings, but there wasn't much improvement. Struggle finally came to a regular schedule of placing a new plate up against bottom of leaking hopper, then welding it while system stayed in regular service. Then three weeks later, this job was repeated. Four sheets were often welded on hopper before a breakdown in some other part of system would shut down plant. That would give enough time to replace the hopper's bottom with a single sheet.

Engineer finally came up with a new idea. He took a standard steel sheet and he welded baffle strips against line of sand flow. Baffles were ¼x2-in. steel strips, welded on edge. Spacing was placed so sand would dam up by one baffle, then extend upstream to the next baffle, covering sheet's bottom entirely with inert sand.

After that improvement, wear was so slow that engineer's troubles were over. Sharp abrasive sand slid harmlessly over dammed-up sand on sheet's bottom, causing almost no wear. After 14 months of continuous service, inspection showed NO WEAR, problem was solved. What would *you* have done?

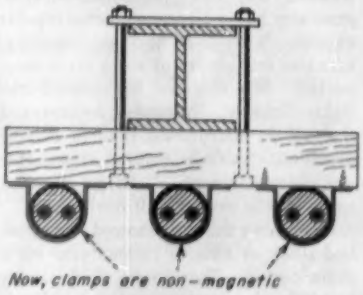
H B MCDERMID *Long Beach, Calif.*

Heating caused by localized inductive effect

A 3-PHASE CIRCUIT carrying about 1000 amp was carried vertically in three 4-inch ID fiber conduits. Each conduit had two 800 Mcm varnished cambric-insulated cables, with asbestos braid covering. The supply frequency was 60 cycles.

Conduits were attached, sketch, to a 4 x 4-in. yellow-pine support. They were clipped to support by galvanized-sheet clamps, which in turn were attached to wood with woodscrews. A 2-in. gap separated clamps.

While there was no complete magnetic circuit around any conductor, heating of each clamp was very noticeable. We solved problem by substituting nonmagnetic material for galvanized sheet. By using hard-brass sheet



we have stopped the heating for good. Note: Here's a good example of a simple solution solving a tough problem.

C O VON DANNENBERG
Brooklyn, N. Y.

(*Continued on page* 128)

More PRACTICAL IDEAS

Begins on page 126

Here's your 'trick' of the month

WHILE IN THE NAVY I took over a watch only to find that we had a bad leak and the bilges were filling up. Machinist's mate I relieved said he had the bilge pumps working but could get no suction —then he walked out of the engine room.

In the forward manifold room I found a 5-in. section of pipe removed from the bilge line. I figured I could place a piece of heavy gasket on the opening, weighted down with a piece of metal. But first I went to the after-pump room. There I found one bilge pump torn apart with no valves between the main suction lines. And the pump valves were lying on the floor plates. I had to work fast so had no time to assemble the pump or to hook up the disconnected pipe.

I started the other bilge pump and heard the suction through the open pump valves. So I placed the four valve disks on the suction seats of the torn-down pump. The vacuum held the valves in place. That pump took suction at once and when the water got down to about 12 inches, I found the trouble. Water was pouring in from a crack in ballast pump's suction line near ship's side. Line had cracked and completely parted under the floor plates. What trick would *you* have used?

F J SCHNAUBELT *Lancester, Calif.*

Single brush causes polarity reversal

MODERN TYPES of direct-current exciters indicate need for anticipating possible trouble. Our 1800-rpm steam turbine-generator had a direct-connected bipolar exciter. With only one unit running, operator left generator room for a short period. While away he noticed the lights flickered. Returning, he observed that all dc instruments read in reverse direction. As there was no chance for any change in connections, he assumed cause was in exciter unit itself.

Examining this unit showed one brush had stuck or cleared commutator for a short period. That broke field circuit and inductive discharge caused polarity to reverse. Since vibration of set caused brush to make contact almost instantly, exciter built up again in a reverse direction of polarity.

We could correct condition at our station as emergency parallel operation of exciters was possible. We then checked cause of initial trouble by momentarily lifting one brush and restoring original polarity.

While this headache may be rare in a modern unit, it does show that not less than two brushes per set offer far greater assurance as a preventive measure.

Recent developments show another approach for providing small exciter units for turbine-generator sets by installing an ac unit with a permanent magnet field; also, a rectifier for changing it to dc. This method has been used for some years on high-capacity units for pilot exciter and has the positive advantage of completely eliminating a commutator and associated wiring connections. What's your experience?

C O VON DANNENBERG *Brooklyn, N. Y.*

Use wheel, not wrench

OCTOBER POWER, p 131, has photos showing an adjustable wrench closing refrigeration valves. Editor warns, "Care in performing this step will avoid burrs on valve stem."

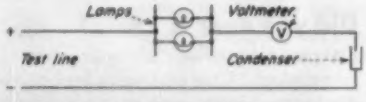
I avoid burrs by filing the square hole of a round handwheel from a spare gate valve so it fits refrigeration valve. In close quarters, spare wheel allows freedom of movement that you can't get from a wrench. Valve is closed quicker, with less chance of damage to it. I keep valve wheel locked up when not in use.

F J ARDALINO *Brooklyn, N. Y.*

Don't forget noise dampers

L W FITZPATRICK reduced noise in air-conditioning systems (Feb, pp 134-135.) I suggest that for any very long run, there should be some noise dampers. These can be either inside or out, or in both places. You can make them of rubber or felt, glued in place, or held by inside or outside clamps. I've found that glue is successful—easy to apply and permanent for this job.

C G HOWARTH *Canton, Ill.*



Easy test for condenser

FOR TESTING CONDENSER, hook up as shown, turn on current. Then: (1) If condenser is good, voltmeter's hand travels close to line voltage and back to zero, or very close. (2) If condenser leaks, hand goes close to line voltage and back to a certain voltage, but not to zero. (3) If condenser is open, hand remains at zero. (4) If condenser is shorted, voltmeter's hand travels over to line voltage and stays there.

B A CROSSON *Cranston, R. I.*

(Continued on page 130)

Cut Costs

... increase profits with

POWERS

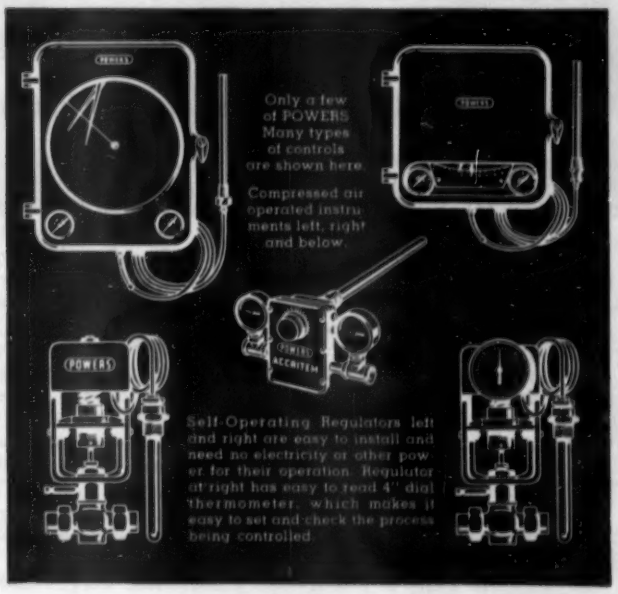
Automatic

TEMPERATURE

and Humidity Control

FLOWRITE
One of Powers Premium Quality Diaphragm Control Valves. They're simple, sturdy and dependable.

VALVES: Available in a variety of body types and inner valves.


Only a few of POWERS Many types of controls are shown here.
Compressed air operated instruments left, right and below.
Self-Operating Regulators left and right are easy to install and need no electricity or other power for their operation. Regulator at right has easy to read 4" dial thermometer, which makes it easy to set and check the process being controlled.

Improved Product Quality quickly pays back a big return on the investment in Powers Control

By eliminating the wastefulness of human errors with the dependable accuracy of Powers automatic control you eliminate losses caused by OVER-heating or Under-heating.

You will get better control if you use the right type temperature controller and proper size control valve for your requirements. An experienced Powers engineer will gladly help you.

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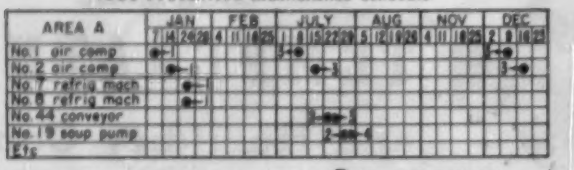
OVER 60 YEARS OF AUTOMATIC TEMPERATURE AND HUMIDITY CONTROL

More PRACTICAL IDEAS

Begins on page 126

1955 Preventive maintenance schedule



Colored pins indicated by:
① White - overhaul or inspection completed
② Red - overhaul due
③ Orange - inspection due
④ Blue - waiting for material
⑤ Green - waiting for shutdown

Preventive-maintenance check sheets

IN SETTING UP a preventive maintenance program you must follow two basic principles: (1) Separate lubrication from maintenance. (2) Simplify maintenance and lubrication records.

Start lubrication program. Standardize on types of oil and grease, cut number to minimum. Oil firm may loan you a lubricating engineer to make survey and assist you in standardizing. He also advises on frequency and amount of lubrication.

Assign lubrication to one person, not to a group. When equipment fails because of lubrication, a clear assignment of duty helps prevent similar failures.

Best program is based on good judgment in scheduling overhauls just before equipment starts to give trouble. For example, an air compressor may need an annual overhaul, also valves may need a quarterly checking. Water pump may require an overhaul every four years. Sharpen up your guessing and decide on overhaul frequency based on past and expected performance.

A loose-leaf book is good for keeping records. Have a history sheet of work done on each piece of equipment. You can easily add sheets or remove them for filing. Some important items to keep in mind are: date, type of trouble (or overhaul), work done, manhours, total cost and equipment downtime.

A pin board in your office provides an effective way of scheduling inspections and overhauls. Make an overhaul schedule, as illustrated, and paste to a soft board. When an overhaul or inspection is due, indicate date by sticking proper-colored pin into schedule. On completing work, remove colored pin and replace with a white pin. This method helps you determine current status of your preventive maintenance program at a glance. No slip-up here.

F C BUTCHER *Grifton, N. Car.*

30 safety hints for electricians

TRANSMISSION MEN, power men, substation men, line men, etc, have safety codes of their own. But many plant electricians do jobs in the same categories, depending on plant size. Here are safety tips:

Be careful. Wire to source of power last, and only after testing circuits for grounds. Disconnect source of power first when working on a circuit before trying to service. This means pulling fuse or opening switch. Treat wires and cables as if they were alive. Work as carefully as conditions allow. Don't allow body to become part of circuit by going to ground or across terminals. Never close a circuit unless you're sure all personnel are clear of equipment.

Remove a tag after you have finished working on a circuit. But never remove a tag, placed by another man, and throw in a switch. Instead, contact that person and get him to remove the tag himself. Always work to specifications of the National Electrical Code. Be sure all connections are tight. Many a loose connection has started a fire.

Circuit breaker. When opening or closing a circuit breaker, stand off and to one side. Do not face it full front. Apply same technique when removing or replacing fuses to avoid any possible electric arc. Don't run wires over belts. Don't step over a belt while it's in motion as it might break.

If cable must be laid on ground, be sure it's heavy-duty type. Don't try to lift brushes from commutator or slip ring while machine is running. Take a tip from transmission men, whose slogan is, "If it isn't grounded it isn't dead."

Never open secondary of current transformer while it's carrying current. Open or close a switch swiftly. Keep metal items, such as finger rings, watches, measuring tapes, clear of live contacts when working about electrical apparatus. Keep necktie and other loose clothing from moving belts or rotating machinery. Wearing a bow tie may prevent an accident.

Use only rubber gloves *you* know have been tested when working on high voltage. Test each time before using. Always wear rubber gloves when working within four feet of primary circuit. Inspect your safety belt frequently for breaks or cuts. Make sure hook is snapped only to the D ring before starting to climb. Double check before trusting weight to belt. When climbing, keep sleeves down to avoid splinters.

Watch these risks. When using portable tools, be sure to ground frame before plugging into outlet. Take special precaution when working inside a cold walk-in cooler. Never cut large cable by placing across knee or holding in hand and drawing knife toward wrist. When installing transformers, be sure all men are clear and installation is closely supervised to limit unnecessary swaying. This prevents crushing men. Never lower tools, equipment into manhole unless man below is alerted.

Resuscitation. Every electrician must know the prone method. If worker is held to a circuit, never try to break circuit with metallic or moist material. Use only dry nonconductor, such as clothing or rope. Make every effort to have current shut off while trying to free a worker from circuit.

B A CROSSON *Cranston, R. I.*

Blow that air system

SET UP A ROUTINE for blowing down air-control systems so every part is blown down once or twice per watch. Even though you have traps on mains, your system will give cleaner air and operate your controls better.

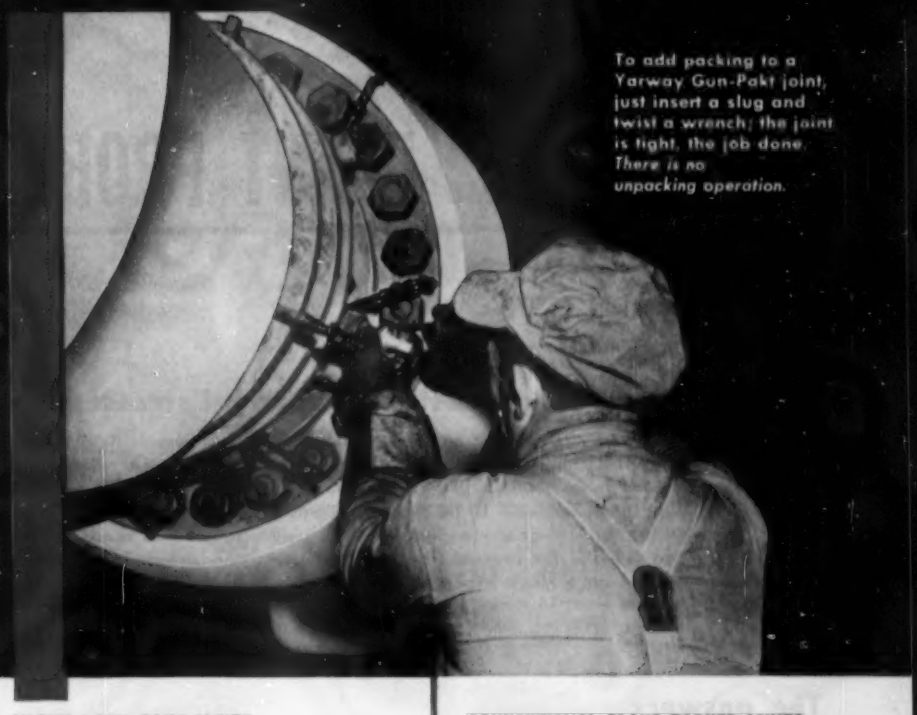
H HOLCOMBE *Los Alamos, N. M.*

Did you know . . .

your Practical Ideas are worth money? Send photos and sketches with brief description and earn extra money.

STARTLING NEW FACTS ON EXPANSION JOINT MAINTENANCE

It may cost less than you think to service expansion joints. Look at these records from three typical users of Yarway Gun-Pakt Expansion Joints:



To add packing to a Yarway Gun-Pakt joint, just insert a slug and twist a wrench; the joint is tight, the job done. *There is no unpacking operation.*

	YARWAY GUN-PAKT JOINTS	CONVENTIONAL GLAND-PACKED JOINTS
STATE UNIVERSITY*	Required addition of only 3 slugs (45 cents) of packing in 5 years. Lubrication only once every 6 months. Total labor time of only 2 manhours in 5 years.	Same lubrication as Gun-Pakt, *plus* gland tightening, *plus* complete overhaul with shutdown for unpacking and repacking every 3 to 4 years. Time for overhaul—25 manhours per joint!
MID-WEST AIRFIELD*	Only maintenance was lubrication and addition of 2 slugs (30 cents) of packing per year. Total labor ¼ manhour per joint per year.	Lubrication and gland tightening required 8 manhours per joint per year—plus complete unpacking and overhaul every 2 to 3 years. Time required for overhaul—20 manhours per joint.
"BIG TEN" UNIVERSITY*	Lubrication only once every 2 months, with packing added as needed. Total labor time charged, 1 manhour per joint per year.	General maintenance requires 6 manhours per joint per year. Complete overhaul required every 2 to 3 years with unpacking and repacking—24 manhours per joint.

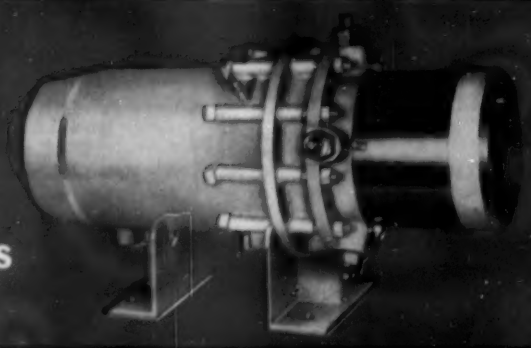
*Names on request.

To get the full facts on Yarway Gun-Pakt Expansion Joints, and how they can save you maintenance money, write for Yarway Bulletin EJ-1913.

YARNALL-WARING COMPANY
100 Mermaid Ave., Philadelphia 18, Pa.

YARWAY

Yarway single-end, welding type Gun-Pakt joint for pressures to 300 psi, heavier design for higher pressures. Single-end traverses up to 12 inches; double-end up to 24 inches.



gun-pakt expansion joints

These PLANT PROBLEMS solved by

The question

How can we estimate thermal stresses in steam lines?

THE FACTS: In modernizing our industrial power plant, we're going to install two high-pressure boilers. Rating of each is 200,000 lb per hr at 1050 psig, 875 F. Main steam header is 10 in. diameter, feeds a noncondensing turbine-generator, pressure-reducing stations and takeoffs for process steam. We've tentatively decided on a single-header design, with bypasses. But we want to make sure that the header has enough flexibility to keep thermal stresses low.

Preliminary layout calls for a U-type expansion loop. How can we make sure its proportions and size are adequate? Where should we locate anchors to get best results? Naturally we want the thrust on the turbine inlet within allowable limits. Do readers know any short-cut figuring methods? What judgment factors are involved?—*RT, April Power*

The answers

Testing model of piping system yields accurate results

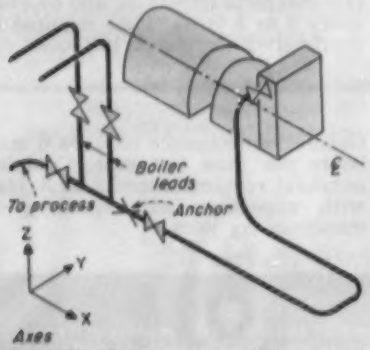
APPROXIMATE CHECKS often fall short of their mark. Where high-temperature steam supplies a turbine, a complete flexibility analysis is justified.

For a layout where design changes are expected, I suggest the model test method. Here, an actual steel-rod scale model of the piping layout is set up. Rod ends are displaced in proportion to steam lead's thermal expansion and end reaction forces measured with strain gages. Forces are in direct proportion to those in actual pipeline.

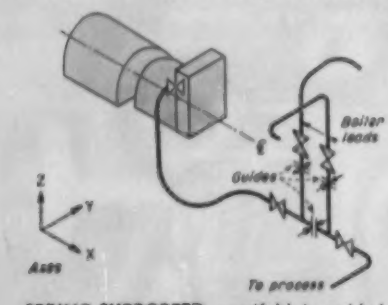
If load on turbine, as figured from model, is too high, model is changed to cut down reaction forces.

This method insures safe loads on equipment, and is general practice in industrial and utilities companies.

J F O'ROURKE, *Mech engineer*
M W Kellogg Co, New York, N. Y.



TURBINE LEAD with manifold anchored near turbine, opposite gravity center



SPRING-SUPPORTED manifold is guided on turbine center line, opposite turbine

Consider boiler, turbine layout in figuring pipe stresses

TO KEEP piping costs down, locate boilers near turbine. For a 2-boiler, one-turbine unit, such an arrangement usually eliminates need for a long header, substitutes short manifold near the turbine with individual boiler leads to it.

Intermediate anchors or other restraints reduce flexibility, tend to increase line stresses and end reaction forces. But allowable reaction at a noncondensing turbine is usually much less than at the superheater outlet. So it may be a good idea to anchor or guide the manifold in a way that reduces reaction force at the turbine—at the expense of bigger reactions on ends of other lines.

If *RT* sets the turbine parallel to and near the boiler-room wall, he can work out the first setup shown at left. Manifold should be in the X direction as near turbine center line as practical. Locate anchor about opposite the turbine's center of gravity. Anchor at manifolds also simplifies stress calculations in all lines tied to manifold.

If turbine must be set at right angles to boiler-room wall, manifold is usually much farther from turbine's center of gravity. So it's a lot tougher to provide enough flexibility between an anchored manifold and the turbine. For this case, the second arrangement, left, may be better. The manifold must then be spring supported. Only the component of reaction force in *Y* direction and moments in *YZ* plane can be absorbed by guides shown in drawing.

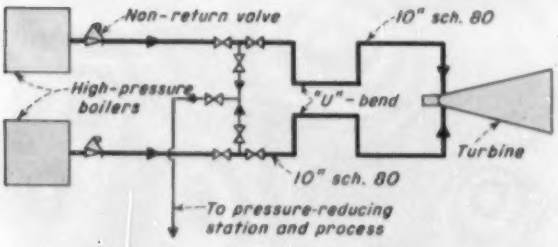
But if *RT* can locate manifold on turbine center line, in elevation as well as plan, he can set it on completely guided rollers. Then, only *X* component of reaction force, from steam leads, is transmitted to turbine.

One last point: Don't overlook figuring end reactions of turbine exhaust.

F JENNE, *Senior mech engineer*
Cincinnati Gas & Electric Co

our readers may be your problems too

HOWARD KALLEN, Assistant Editor



Here's how RT can work out flexibility analysis

PIPING-SYSTEM STRESSES normally divide into three types: (1) thermal expansion stresses (2) stress due to pipe weight (3) internal-pressure stresses. A careful flexibility analysis will give *RT* a steam line that has relatively low stresses, keeps end reaction forces on the boiler terminal connection and turbine stop valve within allowable limits, and isn't needlessly long. Long runs boost material costs.

First step: Consult applicable code. With layout shown in sketch above, make sure the nonreturn valve is close to the boiler outlet nozzle—restricting only a small part of the steam lead to *ASME Boiler Code* design. Remainder of the steam lead is covered by the *Code for Pressure Piping*—eliminating need to radiograph each weld.

Next, decide on possible pressure and temperature extremes. If we assume conditions given for *RT's* plant to be a maximum, we can figure pipe-wall thickness, pick material, and set up space limitations for the line.

For temperatures between 750 and 900 F a 1 chrome-½ moly steel, according to ASTM spec A-335, group P-12 is OK. Its maximum allowable stress, S_a, is 13,650 psi at 875 F. We use the piping-code formula for minimum wall thickness:

$$t_m = \left[(P \times \text{pipe OD}) / (2 \times S_a + 2 \times y \times P) \right] - C$$

where: $P = 1050$ psi; $y = 0.4$, a constant for ferritic materials at 900 F and lower; $C = 0.065$, a corrosion factor. So:

$$t_m = 0.446 \text{ in.}$$

Taking into account a 12½% mill tolerance, we get:

$$\text{nominal thickness} = 0.446/0.875 = 0.510 \text{ in.}$$

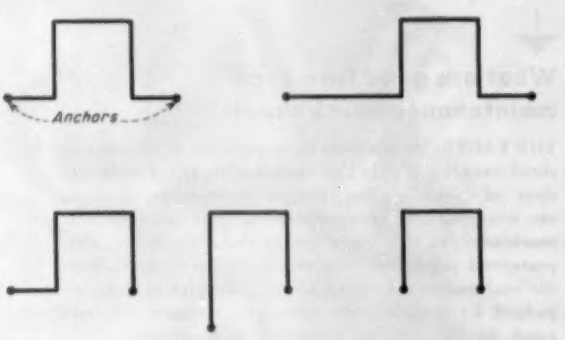
Horizontal loop. *RT* should consider a horizontal-plane loop shown above, right. This setup is self-draining in hot position if boiler outlet nozzle is at a much higher level than turbine inlet nozzles.

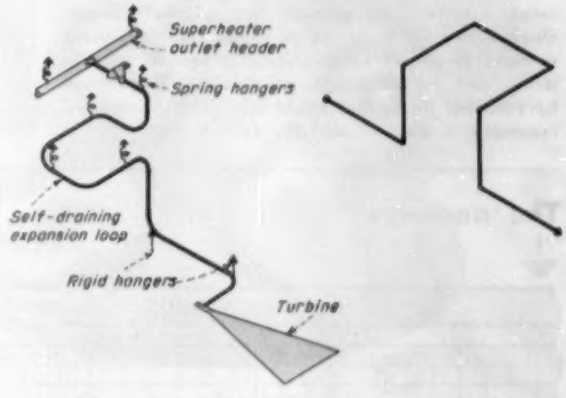
With this loop on constant-support spring hangers, horizontal and vertical movement of the boiler outlet header is absorbed by the loop, like an accordion. Upward expansion of the lead's lower section is also taken up by the loop. Horizontal run to the turbine nozzle can then be supported on rigid hangers—allowing horizontal movement of run, away from turbine only. This naturally cuts down thrust on turbine inlet nozzle.

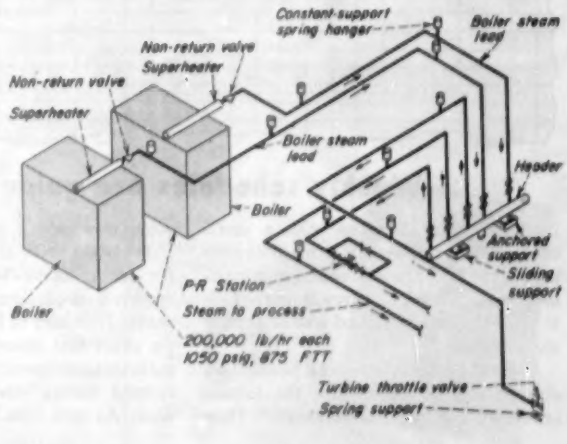
RT should offset the rigid hangers away from turbine, in the cold position, so expanding turbine leads can more readily move away from turbine.

If U bends are preferred, *RT* can choose from several arrangements shown at top, right.

A J BREUGELMANS *New York, N. Y.*







Floating system for short pipe runs

DRAWING ABOVE shows method I prefer—utilizing a floating system for relatively short pipe runs. If direction of expansion must be controlled, locate anchors to guide movement in least objectionable direction.

Stresses are checked by Mitchell or Spielvogel methods.

H B SWYGERT, JR., *Mechanical engineer*
J E SIRRINE CO, *Greenville, S. C.*

Turn page for ideas on maintenance check sheets ▶

More PLANT PROBLEMS

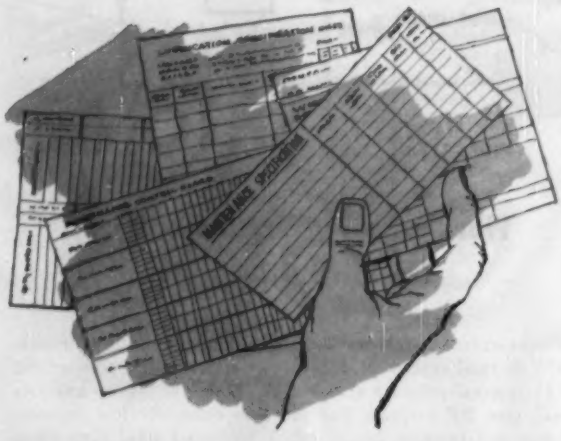
Begins on page 132

The question

What are good forms for maintenance check sheets?

THE FACTS: As plant-services manager in a medium-sized canning plant, I'm responsible for a wide variety of power-service equipment—pumps, motors, air compressors, air-conditioning and refrigeration machinery, to mention a few of the main items. I've permitted production-department supervisors to handle maintenance as they see fit. Results to date, as judged by maintenance costs and outages, are not good. So I'm starting a supervised program.

Although I've mentioned several types of equipment, I believe the general form of maintenance check sheets for them can be similar. I'd like them to cover frequency of inspection as well as specific items, such as lubrication, functioning. Do readers have sample forms that would help me? Am mainly interested in good ideas—*AG, April Power*



The answers

MAINTENANCE SCHEDULE — Sheet No.

Week of the year

21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	
												4									S											255-ton centrifugal compressor
																					S										(a) Speed-increasing gear
		Check oil and maintain sight-cup level																			S										(b) 250-Hp motor and controls
				I						I				I					I		S										(c) Purge units and ½-Hp motor
																					S										(d) Cooler and condenser
																					S										(e) Temp controller
																																15-Hp chilled-water pump
																																5-Hp hot-water pump
		Lubricate steam pressure regulator monthly, clean tank and trap yearly																														Hot water storage heater

Weekly schedules are guide for production departments

PLANT-SERVICE MANAGER with a small central staff can set up a maintenance procedure and allow production-department supervisors to carry it out. This is often the only practical way of getting the job done.

Biggest problem is getting production departments to appreciate the importance of regular maintenance. They often overlook it to meet production.

Schedule form above acts as a guide for maintenance work. Set up on a weekly basis, it lists each piece of equipment. Numbers in boxes refer to a master chart that describes equipment and maintenance operation that must be performed during week listed above column. As each item is completed by production departments, it gets checked off. Forms are then returned to the plant service manager. He tells at a glance what work was actually done. And the responsibility is fixed with the man who checks off the item. Coupled with an occasional field check, all equipment gets attention with a minimum of work.

E F WEHLAGE *Fairport, N. Y.*

Here are key points for planned maintenance

SINCE *AG* is mainly interested in ideas, I think he'll find these useful: (1) Define just what the actual duties and responsibilities of the maintenance department are. (2) Schedule maintenance work by placing the analyzed jobs on a daily operations-and-scheduling sheet. (3) Scheduling sheet should give each maintenance crew enough info to cover a day's work—according to a priority system. (4) A scheduling rack is one of the best ways to give a foreman good maintenance control. Job information on it includes: date wanted, date written, code number, job description, jobs analyzed, etc.

B A CROSSON, *Plant engineer*
Brown University, Providence

New questions, also more on maintenance check sheets, p 136

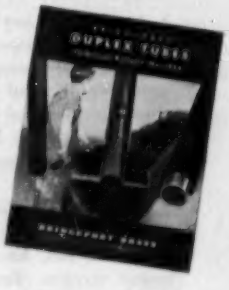
It's LAST cost that counts!

. . . and Bridgeport Duplex Tubes last longer

In the long run you save money with Bridgeport Duplex Condenser Tubes! Resisting different types of corrosion, inside and out, they eliminate the need for frequent retubing and shutdowns . . . often improve heat-transfer characteristics . . . reduce maintenance costs substantially when the proper combination of metals is used.

Bridgeport Duplex tubes are available in many combinations to match your service requirements. For example: copper-steel, cupro nickel-lead, red brass-aluminum.

Call your local Bridgeport Sales Office for complete information and the help of Bridgeport Technical Service. Ask for your copy of Bridgeport's Duplex Tube Technical Bulletin.



BRASS Bridgeport CO.

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Offices in Principal Cities • Conveniently Located Warehouses
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In Canada: Noranda Copper and Brass Limited, Montreal

More PLANT PROBLEMS

Begins on page 132

Advantages of centralized maintenance

With a centrally supervised maintenance program, *AG* gets the following advantages: (1) Managerial control is simpler. (2) Waste is kept to a minimum. (3) Over-all plant operating costs are reduced, since maintenance is treated on a routine instead of an emergency basis. (4) Specialists can be trained for particular jobs. (5) Safety hazards are more likely to be eliminated—making the plant more efficient. (6) Good planning and scheduling get the right number of workers, with enough materials on the job at the right time and place. (7) Men's morale is higher when they are told in advance what must be done and why.

Typical weekly maintenance schedule, right, is for air conditioners in a plant and office building for a year. Foremen note inspections coming up and make out inspection requests. They then check off completed items with a *C*, *O* or *X* on the chart.

Similar forms can be made up for pumps, motors, air compressors, etc.

A J Breugelmans *New York, N.Y.*

(*Continued on page* 202)

WEEKLY MAINTENANCE SCHEDULE
AIR CONDITIONERS

		1	2	3	4	5	6	7	8	9	10	11	...	52
Factory Air Conditioners No. 1	Filters	C					C					C		
	Fans	C									C			
	Controls		X			X			X			X		
	Unit													O
Factory Air Conditioners No. 2	Filters		C					C						
	Fans		C					C						
	Controls			X			X			X				
	Unit													O
Office Building Air Conditioners	Filters			C					C					
	Fans			C					C					
	Controls		X			X			X			X		
	Unit													O
Cafeteria Air Conditioners	Filters		C					C				C		
	Fans		C					C				C		
	Controls	X			X			X			X			
	Unit													O

C – Clean O – Overhaul X – Operational check

YOUR JULY PROBLEMS

1 What's good hookup for feed pumps' motor-control flexibility?

We have two firetube boilers supplying steam for process work. Condensate returns are fed back via a condensate tank and through two motor-driven boiler-feed pumps—one for each boiler. Start-stop operation of pumps is controlled by float-type low-water cutoff and feed regulators. Installation includes piping and valves for feed-pump crossover, so either pump may feed either boiler. But there is no corresponding electrical hookup for crossover feed regulation.

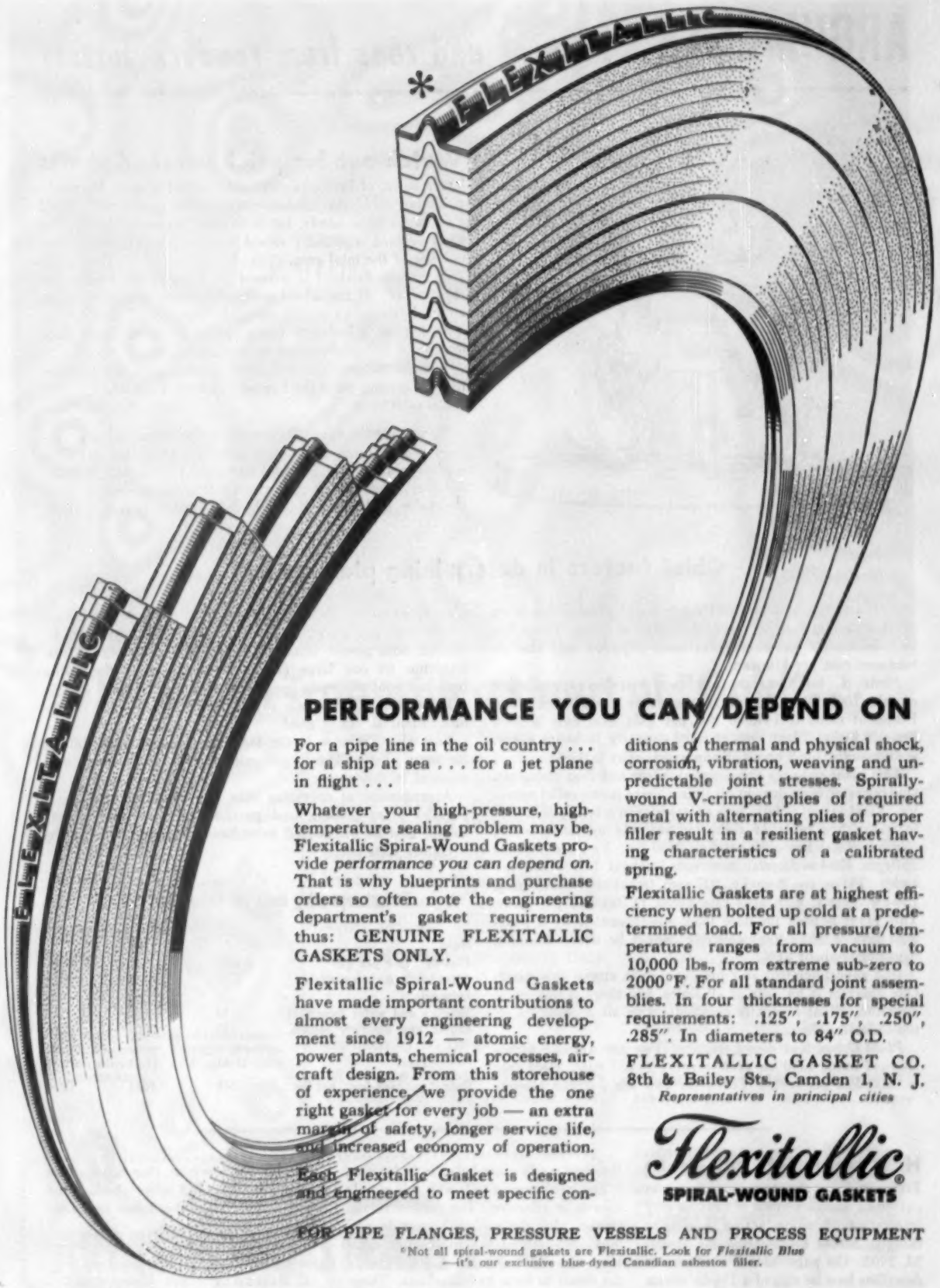
Such a switching arrangement would be highly desirable. I am thinking of using four 3-way switches to do the job, hooking them between the magnetic motor starters, for the feed pump, and the float-actuated feed controls. Is there a simpler way of doing this job? Also, I'm afraid my plan may cause electrical feedback. Can *Power* readers improve on my 3-way switch method?—*HRM*

2 Will NaOH hurt our water-treating filters?

We get our raw-water supply from very shallow wells, in sandy ground, but near marshy land. So we've had continual trouble with organic matter. Water is treated with chlorine at the wells. It then goes through filters, preceded by aluminum-sulfate injection. From here it goes to sodium-zeolite softeners and to our factory. Boiler-feed is additionally split-treated through hydrogen-zeolite softeners. Our filters were continually choked with sand clumps due to algae and slime. Backwashing aggravated the situation since the sand bed was cracked. All incoming algae would pass to the softeners and choke them.

Only thing that helped was cleaning the filtering sand, outside the filter, with hydrochloric acid. Recently we cleaned with sodium hydroxide, once in two to three weeks. Immediate results were excellent. But will we ruin effectiveness of filtering sand by using NaOH once in three weeks?—*DR*

Sit down right now and answer one or both of these problems. We'll pay extra for answers with photos or sketches



PERFORMANCE YOU CAN DEPEND ON

For a pipe line in the oil country . . . for a ship at sea . . . for a jet plane in flight . . .

Whatever your high-pressure, high-temperature sealing problem may be, Flexitallic Spiral-Wound Gaskets provide *performance you can depend on.* That is why blueprints and purchase orders so often note the engineering department's gasket requirements thus: GENUINE FLEXITALLIC GASKETS ONLY.

Flexitallic Spiral-Wound Gaskets have made important contributions to almost every engineering development since 1912 — atomic energy, power plants, chemical processes, aircraft design. From this storehouse of experience, we provide the one right gasket for every job — an extra margin of safety, longer service life, and increased economy of operation.

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Flexitallic Gaskets are at highest efficiency when bolted up cold at a predetermined load. For all pressure/temperature ranges from vacuum to 10,000 lbs., from extreme sub-zero to 2000°F. For all standard joint assemblies. In four thicknesses for special requirements: .125", .175", .250", .285". In diameters to 84" O.D.

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ARGUMENTS . . . *pros and cons from readers' letters*

ALTHEA THORNTON, *Assistant Editor*

Watch out for prick-punched shafts

THAT TRICK of increasing the diameter of a shaft by prick-punching ("Marmy solves two tough problems," April POWER) is often handy, but it has one nasty drawback. The shaft surface is actually raised over only a very small percentage of the total area.

When the flywheel is pressed on, tops of the bumps are sheared off. If the wheel were withdrawn and pressed on again, it would go on all too easily the second time.

So it's much better to use a shrink fit, or to leave shaft outside in freezing weather so it shrinks down.

Another danger is that if there is every any slip between the two mating parts the bumps will soon wear off.

PAUL HOBSON *State College, Pa.*

MARMADUKE'S NOTE: *Bilgewater on prick-punching undersized shafts if you don't know what you're doing. My 6-in. shaft was a snug fit, so prick-punching it was OK. Trouble is some jackass will try it on a shaft 1/64- or even 1/32-in. undersize and someone will be killed when it comes apart.*

Chief factors in determining plant costs?

IF YOU ASK ME, cost of operating a diesel plant depends on plant layout, type of service and number of units. These factors determine the number of men required and the attendance cost per kilowatt.

Plant A, for instance, has two 4-stroke turbocharged diesels, 1000 kw each, 360 rpm, runs as a peak-load plant. Fuel-heat value is 144,000 Btu per gal; heat rate is 9000 Btu per kwhr. Plant runs at rated capacity 16 hours a day, is on standby for 8 hours. Running capacity is 85%.

This plant requires one superintendent and four operators. One operator is on duty at all times; there is one relief operator. Plant layout is fair, with accessories in a cramped trench location. See table at right for variable operating costs.

Plant B has five units totaling 2750 kw. Two are 4-stroke 257-rpm 750-kw diesels; heat rate is about 10,000 Btu per kwhr. Three are 2-stroke, 237-rpm, crankcase scavenging, 750-kw diesels, with heat rate about 11,500 Btu per kwhr. This plant is used for base load, supplemented by a peak-load service when total capacity cannot be used. Running capacity is about 81%.

One superintendent and four operators attend this plant. One operator is on duty at all times, and there is one relief operator. Plant layout is excellent, with all accessories on the operating floor.

Plant C has four diesel engines. Two are 4-stroke turbocharged units, 1150 kw each, turning at 257 rpm. Heat rate is 9500 Btu per hwhr. The other two are 2-stroke blower-scavenging units, 2500 kw, 225 rpm, with heat rate about 10,000 Btu per kwhr. This plant runs regularly, supplemented with power from other plants during peak loads. Governor on one large engine is set to carry the swing load and maintain cycle operation. Running factor is 88.3%.

Personnel includes one superintendent and eight operators. Plant layout is good.

Cost of attendance is the factor that varies most among the three plants. The larger units at *Plant C* are more economical in this respect.

Arrangement of operating time, size of units, peak load, parallel plant loading and purchase of secondary power should also be considered in reducing variable plant costs.

HENRY GREINER *Anoka, Minn.*

Variable operating costs for three diesel plants

	Cost per kw, mills		
Plant	*A*	*B*	*C*
Fuel at 12.8¢ per gal	6.96	7.74	7.71
Attendance and supervision	3.52	2.56	1.33
Lube oil	.29	.44	.25
Supplies and water treatment	.32	.36	.25
Engine and auxiliary repairs	.32	1.01	.21
Total	11.41	12.11	9.71
Output per man-hour, net kw	748	1035	1294

How steam jets cut smoke

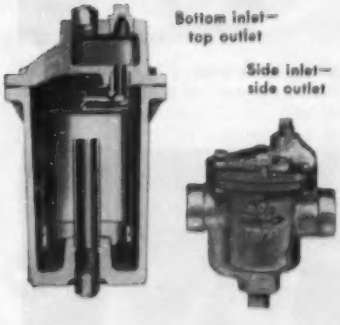
FITZPATRICK'S LETTER on steam jets to cut down smoke (April, p 134) is very interesting. I came across a similar thing in *Steam Engineering* for March 10, 1903. On page 324, F E Downing describes how he rigged a 1½-in. steam line and made some holes in it for jets.

But neither man tells why this simple idea is so effective. The carbon in the smoke, plus the carbon monoxide and dioxide produced by combustion, combine with the hydrogen and oxygen in the steam to form hydrocarbons. These burn and produce heat, then break down again into CO_2 and other products of combustion. No visible flame is noticeable during the process.

In airplane engines, too, water injection cuts carbon and boosts power.

G ROSEKILLY *San Mateo, Calif.*

The Steam Trap with a Heart of "Gold"...



Corrosion- and wear-resistant materials; "frictionless" leverage; precision workmanship — add up to LOW MAINTENANCE.

The exterior of the Armstrong trap pictured above sure looks rough, but inside it has a heart of "gold" for its owner, Chemicals, Inc., Chicago, makers of zinc chloride.

Fuel Saving—coal consumption has been cut ½ carload per month since installing Armstrongs to drain kettle coils.

Time Saving—processing time has been cut from 5 days down to 3 days on one zinc chloride tank since installing an Armstrong trap on each of its three coils.

Maintenance Saving—occasionally holes are eaten right through submerged steam coils, allowing acid to get into traps. The stainless Armstrong mechanisms have withstood this abuse successfully. Trap maintenance generally has been negligible. The trap shown above has been on the job working perfectly for five years without repairs.

Take a tip from Mr. Stanley Nykiel, plant operator, who says *"I've tried other kinds, but Armstrongs work best."* Call your local Armstrong Representative (see classified directory or Thomas Register) or write:

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Application Engineered
ARMSTRONG STEAM TRAPS

SEND FOR CATALOG J
The 44-page Steam Trap Book gives complete trap data and prices plus useful selection, installation and maintenance information. Armstrong traps also catalogued in Sweets and Chemical Engineering Catalog.

515J

HOW TO

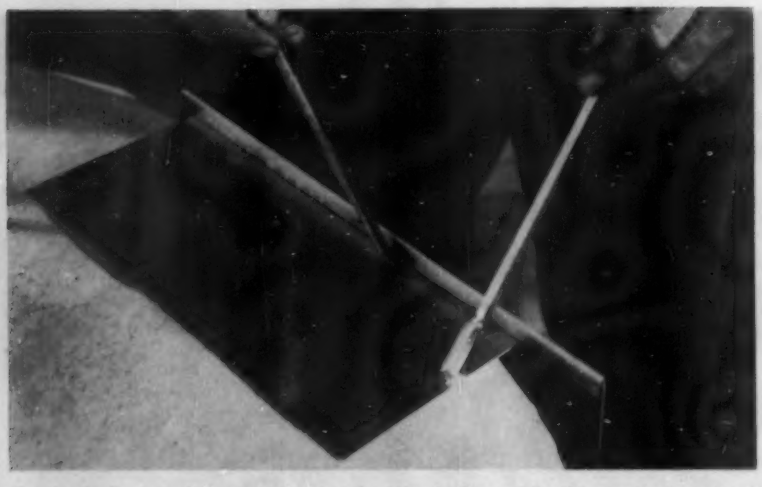
solder stainless steel

► STAINLESS STEEL is too smooth for good adhesion, so roughen with abrasive cloth. Surface smoothness may cause flux to stand up in drops. To overcome, add one teaspoonful of glycerin to one cup of stainless soldering flux. These fluxes are corrosive, so neutralize quickly after making joint. Wash entire part with sodium carbonate (5 to 10% concentration) using soft rag. Immerse part completely if possible. *Never let flux remain on material.*

After neutralizing, rinse with clear water. Water spots come off with Bon Ami. Solder is usually 50-50, or half tin, half lead. Use large soldering iron, heated just above melting point of solder. This helps stop buckling caused by small, very hot iron.

Based on 53-page brochure, *Welding, brazing, soldering and hot cutting.*

Republic Steel Corp, Cleveland, Ohio.



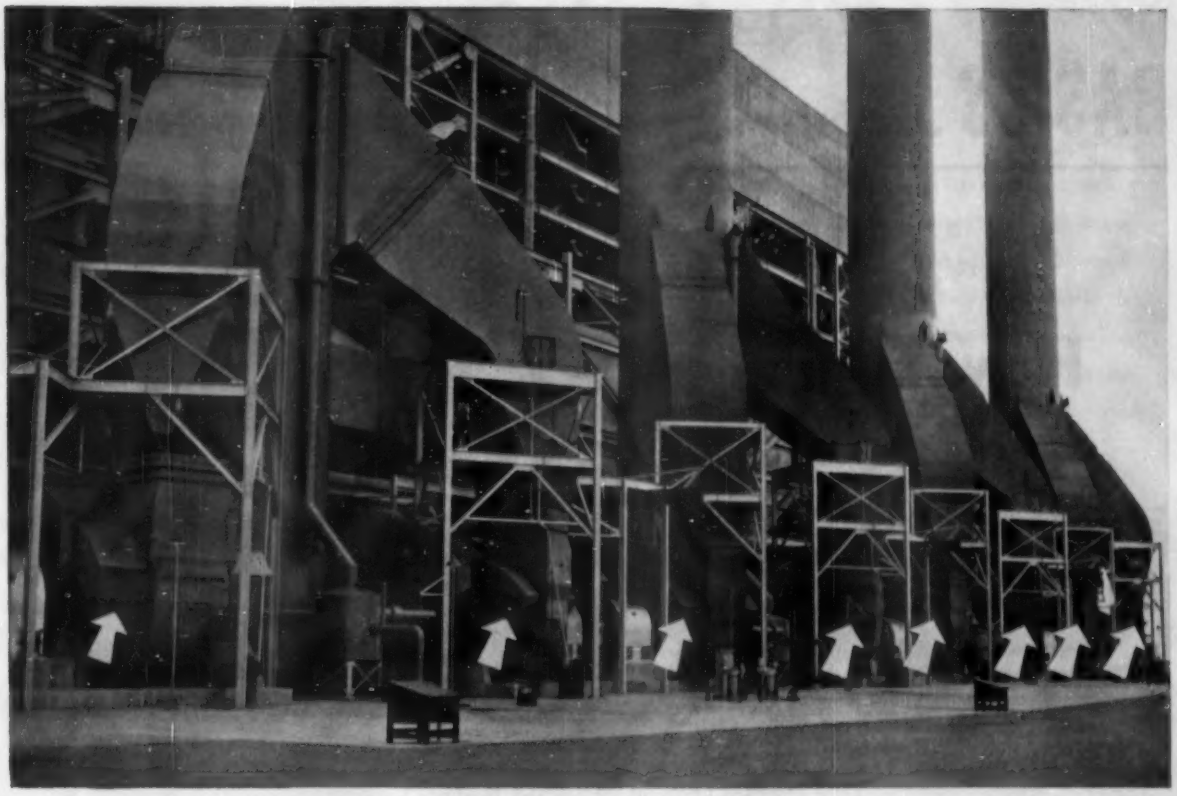
1 Apply flux carefully to surfaces to be joined. For good etching action, you may have to add one teaspoonful of glycerin to one cup of stainless soldering flux

2 Tack. This secures pieces in position, and controls buckling and warping

3 Solder with a large iron, heated just above the melting point of the solder

4 Scrape excess solder with slightly softer stainless-steel tool as shown

5 Neutralize the area immediately after soldering; rinse in warm water; dry



Pacific Gas & Electric Company's Pittsburg (California) Station

New Pacific Gas & Electric's Pittsburg Station . . . 660,000 KW . . . Uses 16 Westinghouse Mechanical Draft Fans

Largest Steam Plant in West Uses Westinghouse Fans for Induced and Forced Draft

Here, eight Forced Draft and eight Induced Draft Westinghouse Fans and Motors serve four boilers, each producing 1,135,000 pounds of steam per hour at 1850 psig and 1,000° F.

Two Forced Draft Fans driven by 900 hp motors provide 219,000 cfm each at 20.1" static pressure.

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These mechanical Draft Fans are specifically designed for outdoor installation.

For power generation—or for any other air handling job, let Westinghouse-Sturtevant put air to work for you—economically, efficiently.

FOR MORE FACTS on the industry's most complete air handling line, call on the "Man with the Facts", your Westinghouse-Sturtevant Sales Engineer, or fill in the handy coupon below.

Over-all view of Pacific Gas & Electric Company's Pittsburg Station showing four huge boilers and 16 Westinghouse Forced Draft and Induced Draft Fans.

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BASICS . . . *bringing engineering theory down to earth*

TOD WALDRON, *Assistant Editor*

How fuels burn-7

BURNING TIME depends on distance

► CONTINUING last month's discussion of suspension firing in actual furnaces, we now concern ourselves with soot and smoke. With either coal or oil, some carbon formerly held in hydrocarbon compounds breaks away as free carbon. And, of course, solid carbon accounts for a substantial part of most coal. So we always have the problem of burning carbon particles. As pointed out in previous Basics, this proves extremely difficult even with ample time.

These carbon particles form the germ of smoke and soot. If the furnace is too small and the cold surfaces (screen tubes and waterwalls) are badly located with respect to the flame, carbon cannot possibly burn to completion. Too much cold surface in the furnace gives the same result.

All the basic steps of combustion—bringing air and fuel together, raising the mixture to ignition temperature, sweeping away successive layers of gas from the fuel particles, burning carbon as far as possible—occur while fuel and air travel from burner to furnace outlet, an extremely short time interval (see illustration). Just how much the distance traveled and the speed of travel affect complete combustion of carbon particles depends on whether flow is turbulent.

Turbulent mixing. By turbulence, we mean a condition in which fuel and air whirl and eddy in irregular paths instead of flowing in stream lines from the burner to the furnace outlet. This condition has several beneficial effects: (1) There is an increase in the time available for combustion. (2) Better mixing of fuel and air results. (3) Fuel and air move past each other at higher velocity, thus helping to sweep away combustion products and expose fresh fuel surfaces. It has been said before, and appropriately, that successful combustion depends on the three T's—temperature, time and turbulence.

Ash and slag. What about mineral impurities (ash) found in many fuels and particularly in coal? They play an important part in practical combustion.

These impurities, of course, do not burn. In suspension firing, if nothing else happened, some particles (flyash) would be carried out of the boiler with the combustion-gas stream. Others would drop out of suspension to settle in the furnace or boiler passes.

But the story isn't as simple and straightforward as this. Entering into it are the nature of the ash and, to some extent, the effect of surrounding conditions. The result is that the ash becomes plastic and sticky. If it comes in contact with relatively cold surfaces while it is in this plastic state, it forms slag coatings. Formation of this material on heating surfaces reduces rate of heat transfer, hinders gas flow through boiler passes and creates a maintenance problem. For pulverized coal firing, furnace design helps eliminate slag as a major problem. With oil firing where ash contains vanadium and sodium, fuel additives may be needed to prevent severe blockage of boiler passes and corrosion of heating surfaces (POWER, November 1954, p 100).

Fuel-bed firing. After the quick run-through of suspension-firing fundamentals, we're ready to take an equally quick look at fuel beds. In this kind of firing, fuel is pushed, dropped or thrown on a grate in a high-temperature region within the furnace. Air flows upward through the grate and through the fuel bed that forms on it. The "green" coal is heated, volatile matter distills off and coke is left on the grate. Coke burns to a mixture of carbon dioxide and carbon monoxide, and ash remains.

Volatile matter of the coal, and carbon monoxide from the coke burn over the fuel bed. Air needed for this combustion comes from primary air coming up through the grate and fuel bed and, usually, secondary air admitted to the furnace above the grate. Thus, anywhere from 40 to 60% of the coal's heat is liberated over the fuel bed. We thus see that burning of gases is still a big part of the job even with fuel-bed firing.

To help understand what happens in the fuel bed, divide it into four zones, one above the other. In actual beds, location and shape of these zones vary depending on grate construction and how the fuel reaches it. For simplicity, we can visualize the beds as more or less uniform layers extending across the grate. From top down, these zones are: distillation, reduction, oxidation and ash. We will discuss these zones further in next month's Basics as well as going into other aspects of fuel-bed firing.

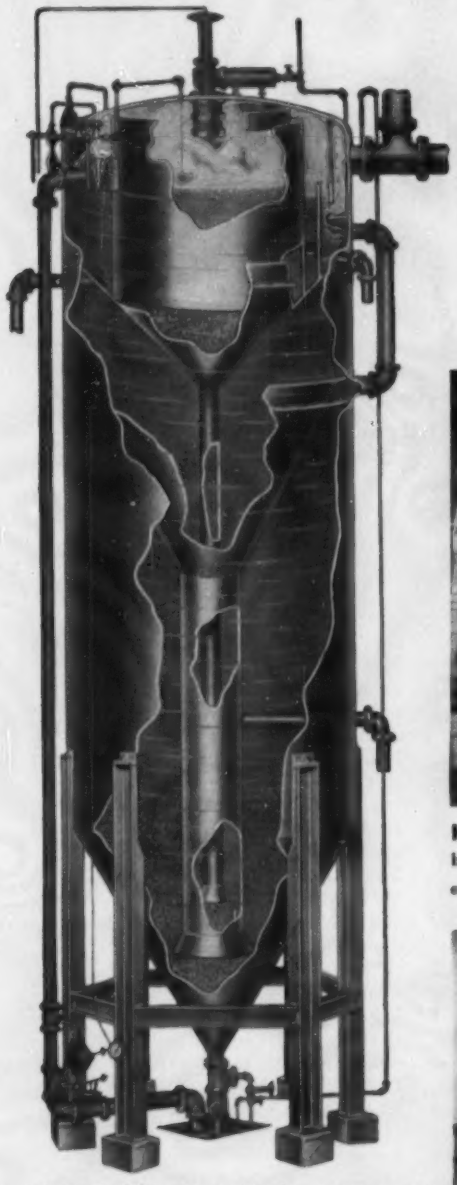
PREVIEW

Next month's Basics winds up the series on how fuels burn. Starting in September, there will be a new series. This time it will be on fluid flow. The treatment will be the same — basic theory put in easy to understand terms. Both compressible and incompressible fluid flow will be treated. Analogies will help you visualize various aspects. Effects of viscosity will be brought in.

Because there are innumerable applications of fluid flow in power plants, this newest series should prove worthwhile as well as interesting. Howard Kallen, Assistant Editor, will handle it.

In Hot Process Softening, too

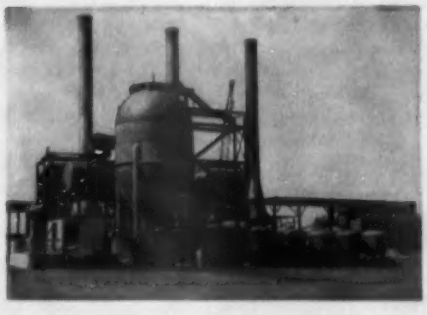
BELCO Builds a Complete Line-



Belco-designed equipment provides high operating efficiency at low operating costs. Many of the country's largest industries rely on Belco for their water conditioning equipment. For example, Belco has built the largest fully automatic demineralization plant in the world and is currently furnishing one of the largest hot lime zeolite installations. A consultation with Belco could lead to lower operating costs for you, too. Write or call for technical assistance at any time.

HOT LIME SODA — Installation in boiler house at large eastern oil refinery. Has capacity of 200,000 lbs/hr.

HOT LIME SODA — Installation in large southwestern utility. One of three units with 90,000 lbs/hr total capacity.



HOT LIME BELCOLITE — Installation at large southern chemical company. Capacity 600,000 lbs/hr. This plant embodies "thoroughfare" operation of separate deaerator and hot process tank. The large hot process tank was designed, built and erected by Belco under its contract with customer.

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Processes for Removal of Water Impurities

Boiler Feedwater Heaters • Water Softeners • Filters • Clarators
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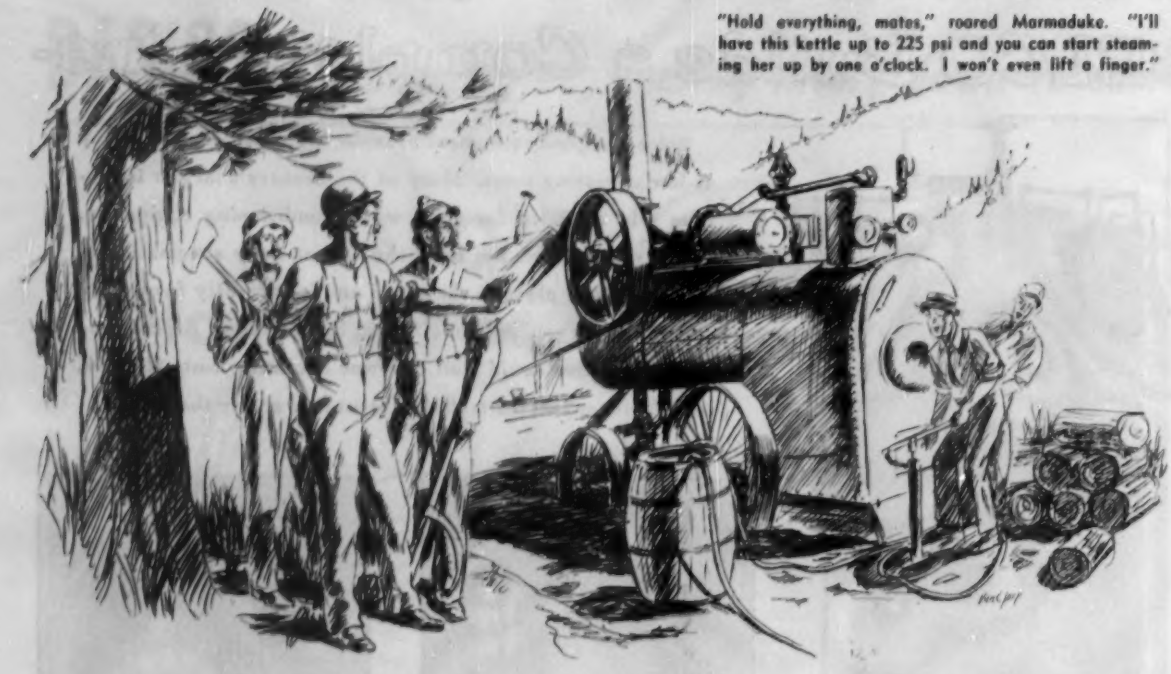

"Hold everything, mates," roared Marmaduke. "I'll have this kettle up to 225 psi and you can start steaming her up by one o'clock. I won't even lift a finger."

Marmy gives her a hydrostatic

► ONE NICE THING about an editor's job on an international magazine like POWER is that my old shipmates know where I am. So it's always a pleasant surprise when the receptionist comes to my desk on the 26th floor and tells me someone I haven't seen for years is "aboard."

That's what happened this afternoon. Jack Regan was in town from Reading, Pa. Jack and I sailed the United Fruit ships during the depression. Now he owns Reading's largest general-storage warehouse down by the freight yards—the Wertz Warehouse Co.

After shaking hands and batting the breeze for a while, Jack and I headed for Marmaduke Surfaceblow's office above O'Houlihan's Machine Shop & Engine Works. Climbing the creaky old stairs, we could hear the leather belts flapping and squealing in the machine shop. A grinding wheel groaned away as it chewed into a piece of metal.

Reaching the second floor, we stood in front of the bright red door with the glazed glass. It had the old consulting engineer's name painted on it in large letters. Noisy chatter coming through the door told us the old boy was inside and had plenty of company, as usual. I opened the door and the two of us walked in. Marmy sat at his roll-top desk jotting figures in a little black book. An assortment of salty looking characters sat around, chewing the fat while smoking and drinking coffee. The old pot-bellied stove was going full blast and the coffee pot simmered away.

"Meet Jack Regan, an old shipmate," I said, trying to drown out the noise. "Jack and I sailed on the turbo-electric steamer *Platano* in the Fruit Company," I said, walking toward Marmy.

But Marmy kept working away and paid no attention to us. "Jack wants to talk to you about his new freight elevator and also a maintenance schedule for his fleet of lift trucks," I said, loud as I could, trying to get the cantankerous old mariner's attention.

"Bilgewater on lift trucks," suddenly roared Marmy, throwing down his pencil and reaching for the coffee pot. "I'll tell you guys about a problem I solved and I didn't have to lift a finger. All I did was take on fuel and my problem was solved an hour later."

That blast quieted things down instantly. Marmy worked up a vacuum and took a drag on his coffee. Then he leaned back in his swivel chair, plopped his size-16 canal boats up on his desk and lit his cigar butt. Jack and I found a place to park.

"Back in 1923 I headed for the Maine woods," bellowed Marmy in his foghorn voice. "My old shipmate Epps Grundy ran a sawmill up there and wanted me to help him out for a while. I bought a model-T lizzie in Boston for 50 dollars and headed for his lumber camp. After getting lost down a narrow forest road, I finally found the place about 50 miles up a river from Passadumkea. His operation was off a bumpy dirt road next to a creek.

"It was about noon and I found Epps and his gang of sawmill hands standing around his boiler, near the creek. There seemed to be something wrong, so I edged near. It was the usual portable locomotive type found around most small sawmills. She had a horizontal steam engine on her shell that drove the big circular saw through a long flat belt. That boiler reminded me of the big steam thrashing engines I had oper-

(*Continued on page* 204)

MUD DRUM as opened after one year on line with THE *nalco* SYSTEM

Unretouched photo of Nalco treated boiler at Georgia Institute of Technology, Atlanta, Georgia

● Calling this a mud drum serves only to identify its location . . . it is perfectly clean after a full year on line. The unretouched photo was taken immediately after the drum was opened. No wash-out was necessary. Not only is the drum free of scale and corrosion . . . Nalco sludge conditioning operated so effectively that even under the static, off-line draining condition, no sludge deposited in tubes or drums.

The Nalco System can get results like these, economically, in *your* plant—regardless of boiler size or pressure. Write or phone Nalco today for action on a complete water treatment program.

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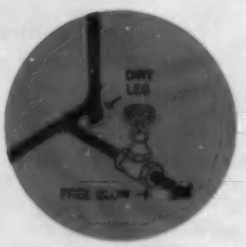
LOOK INSIDE any valve that has failed in close-control steam service. Seating units are scored and grooved beyond repair. Called "wire drawing" or erosion, — it's proof that closely regulated steam acts like a "vapor drill", which quickly knocks out ordinary valves.

Jenkins Plug Type Valves have been engineered in every detail for maximum wear in such valve-killing service. The stainless steel Armor Seat defies the "vapor drill", and Jenkins quality throughout gives them top rating for wear-proof and trouble-proof performance.

Make your own test . . . in your toughest steam service . . . or anywhere that abrasion or erosion causes frequent valve failure. Compare, part for part, with any similar valve. You'll find that, again, Jenkins *extra value* pays off in longer life and lower maintenance cost.

For any close-control steam service

For best resistance to abrasion



BLOWOFF

THROTTLING

BLEEDERS

your best defense is

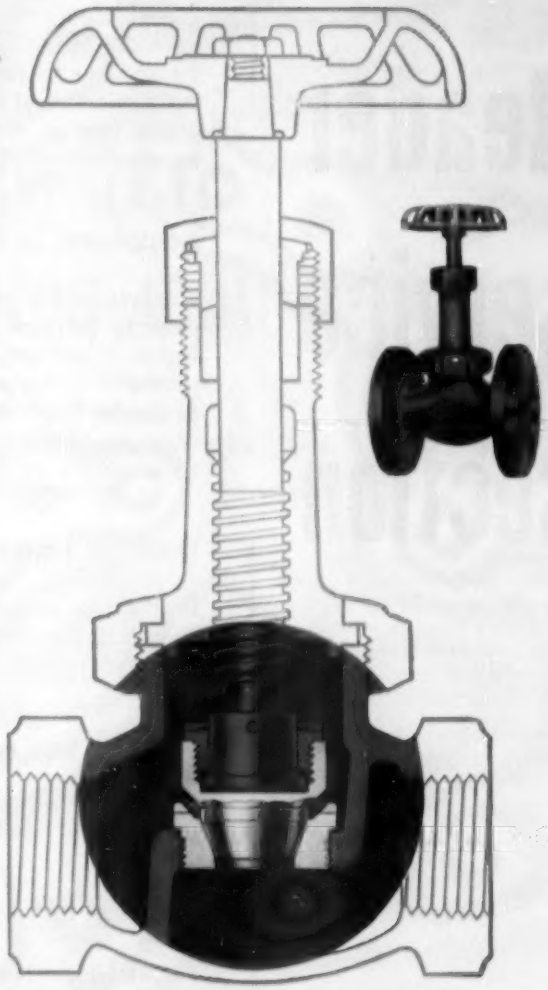
JENKINS BRONZE PLUG TYPE VALVES

with the

500 BRINELL

STAINLESS STEEL

Armor Seat



Plug and seat ring are Jenkins JX500, a Stainless chromium alloy steel made to Jenkins high strength specifications, heat-treated to 500 Brinell. Seating surfaces are superhard and mirror-smooth, offer highest resistance to galling, cutting, abrasion, and erosion. Wide, steep, 30° total taper permits extremely close regulation of flow and vapor-tight closure.

The stainless steel plug is securely fastened to the spindle with a bronze locknut. Spindle is aluminum bronze with a tensile strength exceeding 70,000 lbs., — has high corrosion resistance.

300 lb. 200 lb. 150 lb.

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Reader service section

Start with these quick samples . . .

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is job of new inspection tool that makes use of radioactive cobalt-60. Capable of "seeing through" 7 in. of steel, it requires only one-third the exposure time of a million-volt X-ray machine. Want the full facts? Turn to Reports from the Field, your information center for what's new and what it means to you . . . . . p 150

Read all about . . .

the sodium-graphite reactor's approach to economical nuclear power, and the application of gas turbines to atomic plants. Get your information in digest form by reading Technical Briefs. Fast-reading summaries of papers presented at American Power Conference and AIEE sessions. p 152

Equipment causing headaches?

Then you want to scan Plant Equipment News, the regular roundup of new products designed to solve your problems. This month's feature items include a balancing machine for accurately detecting static and dynamic unbalance in runners, rotors, flywheels, etc, and the facts and figures on Carrier Corp's new absorption refrigerating machines – 100 to 700 ton units for large-capacity air-conditioning and process-cooling installations. Begins on . . . . . p 156

Don't be squeezed out . . .

if it's data on compressor equipment you're after. Order bulletins 15 through 20 from this month's Free Literature. To secure these, or any of the catalogs listed, use handy postcards . . . . . p 165

You say you're 'refined' . . .

Are you? Or are you just a hunk of raw material? George Edwards asks the questions, has the answers in his Scrapbook . . . . . p 168

Plan to visit . . .

the first trade fair of the atomic industry, in Washington, Sept 26–30. Your complete Calendar of Events appears among the advertising pages. Tells you what's going on, where, when and whom to contact for details.

For other timely ideas, see following service pages ▶

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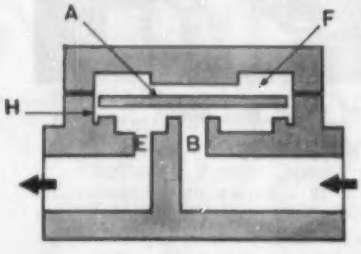
ACTUAL SIZE

this new trap virtually eliminates maintenance

SOLID STAINLESS STEEL DISC ACTS AS VALVE HEAD

HERE'S HOW IT WORKS!



Air and/or condensate raise valve seat disc A, discharge thru E. When steam follows, greater velocity causes it to strike body at H thus building up pressure in chamber F. This causes disc to seat, closing tube B. As pressure in F decreases by condensation, pressure in tube B raises disc and cycle is repeated.

The Sarco Thermodynamic Trap has proved successful on steam mains and separators; headers and soot blower pipes; engine and turbine stop valves, separators and casing drains; alternate heating and cooling applications.

2098-B

A solid stainless steel disc—practically indestructible—is the only moving part!

MOST striking feature of the Sarco *Thermodynamic* Trap is its simple maintenance-free design. There's only one moving part—a solid stainless steel disc that practically lasts forever. There are no other moving parts to wear out or cause trouble.

Condensate, air and steam act directly on the disc valve which opens to discharge condensate and air—snaps shut to contain steam. There are no mechanical devices required to operate valve (see diagram at left). That means practically endless trouble-free operation.

Other advantages: small size, easy installation, not affected by shock or vibration, immunity to corrosive elements with all wearing parts stainless steel, same valve head and seat for all pressures to 600 psi and temperatures to 950° F.

Check these advantages to your own satisfaction at absolutely no cost. We'll send you a trap for trial. All you do is fill out the coupon and mail it in.

SARCO COMPANY, Inc.
Empire State Building, New York 1, N.Y.

MAIL COUPON TODAY FOR TRIAL

Sarco Company, Inc., Empire State Bldg., New York 1, N.Y.
Gentlemen: Please send me a Sarco Thermodynamic Trap for a 60-day trial, requirements as checked.
Size: ½"... ¾"... 1"... Operating Pressure:.....psi

For installation on.....

NAME_____

FIRM_____

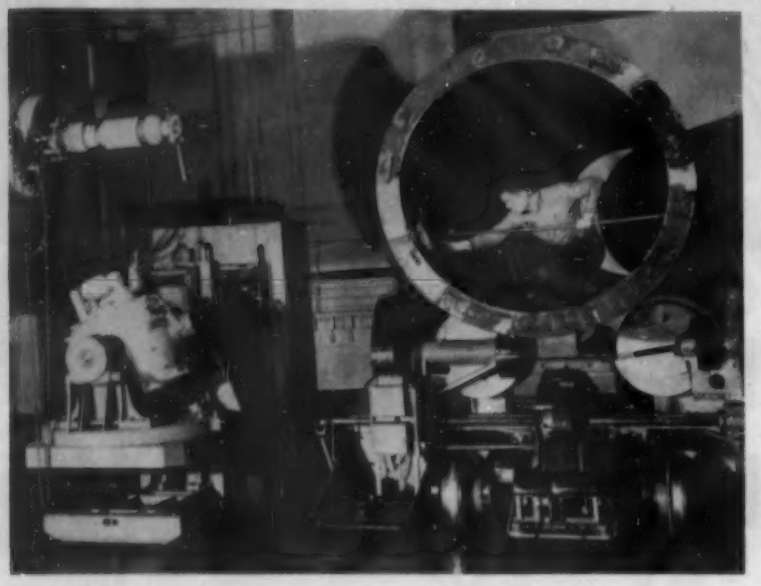
ADDRESS_____

CITY_____ STATE_____

REPORTS FROM THE FIELD

What's happening in power and what it means to you

For Calendar of Events see page 218



Radiographing machine can see through 7-inch thickness of steel

► A NEW INSPECTION TOOL that makes use of radioactive cobalt-60 and is capable of radiographing — "seeing through"—thickness of steel to 7 in. has been developed by The Babcock & Wilcox Co. The unit, called the "Isoscope" has been under study and development for 3 yrs. It requires only one-third the exposure time of a million-volt X-ray machine, the B&W announcement said, and paves the way for wider use of atomic energy in this industrial use. Photo above shows the machine radiographing the steel walls of a typical pressure vessel.

The largest allocation of radioactive cobalt-60 ever authorized to industry for radiographic work was assigned to B&W for the "Isoscope" at Oak Ridge National Laboratory in Oct 1954. The material was loaded into a dual-purpose spherical lead container designed to handle the radioactive material during shipment. The container was converted into part of the "Isoscope" on arrival at its destination. This lead sphere is encased in a steel jacket having a cylindrical rotor section. By revolving the rotor 180 deg the radioactive source can be brought from "safe" position to a point in line with the coned opening in the steel jacket allowing a beam of radiation to escape. Unit can thus be turned "on and off," the announcement states.

Total charge placed in the unit is 1008 curies of cobalt-60, comprised of small disks stacked on top of each other. Radiation is taken from top of this stack so that the focal spot size compares favorably with existing high-voltage X-ray equipment.

The balance of the "Isoscope" consists of a modified electric platform lift truck having a "lead cab" built on the back and a "turn-table" mounted on the front platform. Trunnions on the turntable receive the lead ball containing the radioactive material. Cover plates mounted on top and bottom of lead balls carry the cylindrical rotating mechanism. Assembled unit can be raised or lowered 8 ft, rotated vertically 210 deg and horizontally 360 deg.

Utility lines up 25-year gas supply in novel deal

► PUBLIC SERVICE CO of Oklahoma has gone direct to the producers to line up a 25-year fuel supply for its big Tulsa generating plant. They will buy more than a trillion cubic feet of natural gas from Phillips Petroleum Co and Magnolia Petroleum Co during the 25-year period. Initial price is 12 cents per MCF, with upward adjustments later.

There are several unusual features in the arrangement. First, the deal bypasses the gas transmission industry. Public Service Co needed a long-term gas supply at a known price. It is understood that they had been unable to obtain a long-term commitment from Oklahoma Natural Gas Co.

Second, the 140-mile 24-in. pipe line carrying gas from the Springer Trend area in Southern Oklahoma to the Tulsa station is being built by a new firm, Transok Pipe Line Co, headed by Tulsa attorney John M Winters Jr. Public Service Co and the producing companies

(*Continued on page* 216)

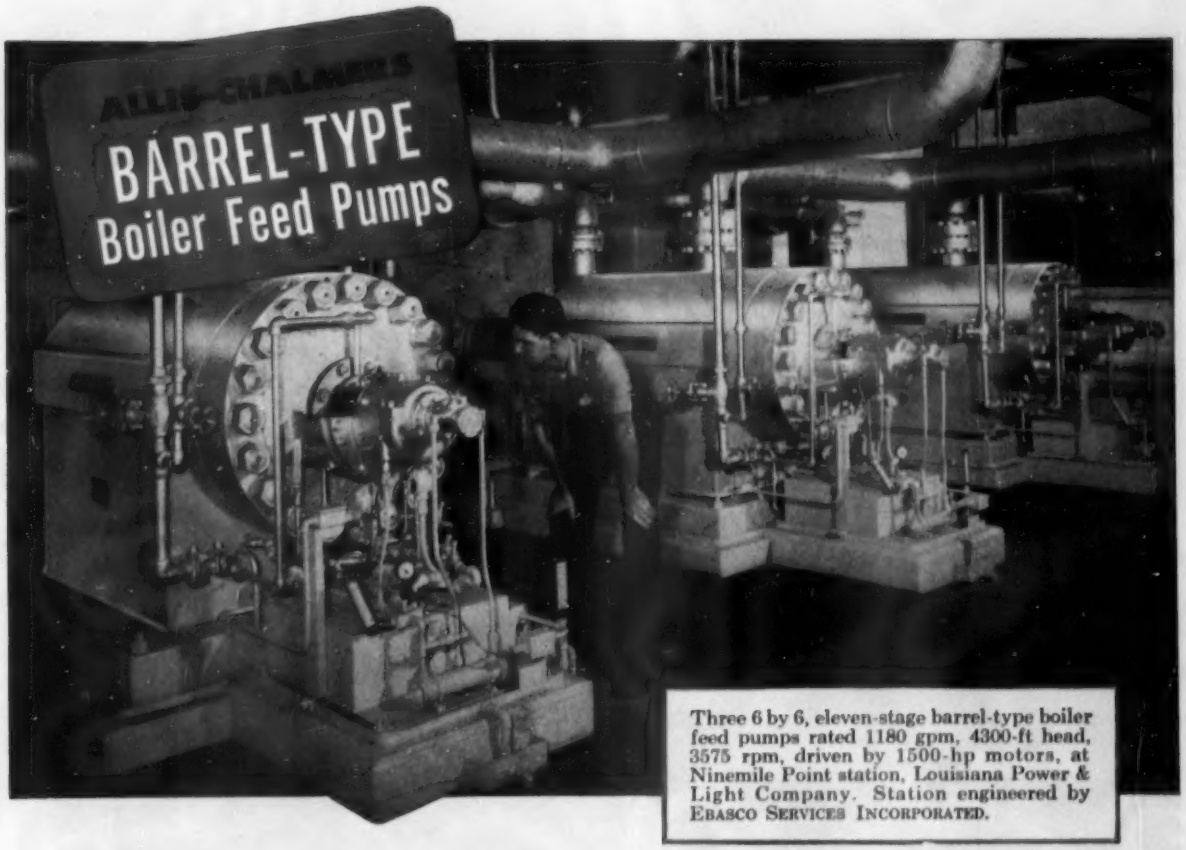
Giant sugar mill opens in West Indies

► CENTRAL PALMA, on the eastern end of Cuba, will place a huge, new mill in operation. The mill is expected to set new standards for grinding efficiency in this greatest of sugar producing areas.

The 18-roll tandem mill, built by Farrel-Birmingham Co, was purchased by Cuban Dominican Sales Corp, subsidiary of West Indies Sugar Corp. Worthington Corp supplied the steam turbines and remote centralized controls that will drive and control the mills.

Each of the six 3-roll mills has its own turbine drive, capable of develop-

(*Continued on page* 216)



Three 6 by 6, eleven-stage barrel-type boiler feed pumps rated 1180 gpm, 4300-ft head, 3575 rpm, driven by 1500-hp motors, at Ninemile Point station, Louisiana Power & Light Company. Station engineered by EBASCO SERVICES INCORPORATED.

First Choice with Louisiana Power & Light Company

A proved service record the country over . . . simple, low maintenance design . . . high efficiency performance — these were some of the factors that led Louisiana Power & Light Company to choose Allis-Chalmers barrel-type boiler feed pumps for their Ninemile Point station.

Features Keep Operating Costs Low

First stage has twin, single-suction impellers to give low NPSH requirement for highest efficiency under fluctuating loads. Impellers, mounted back to back, balance axial forces without use of balancing drum. Double volute casing maintains radial balance under fluctuating load. Expansion joint and shaft seals are brought to outside of pump where they may be inspected often and worked on easily, if required.

Complete Unit From One Source

Allis-Chalmers can supply the complete pumping unit — pump, motor and control — of coordinated design and manufacture. You get one responsibility — one guarantee of satisfaction.

Get complete information on Allis-Chalmers barrel-type boiler feed pumps. Call your Allis-Chalmers District Office or write Allis-Chalmers, Milwaukee 1, Wisconsin, for Bulletin 08B7899.

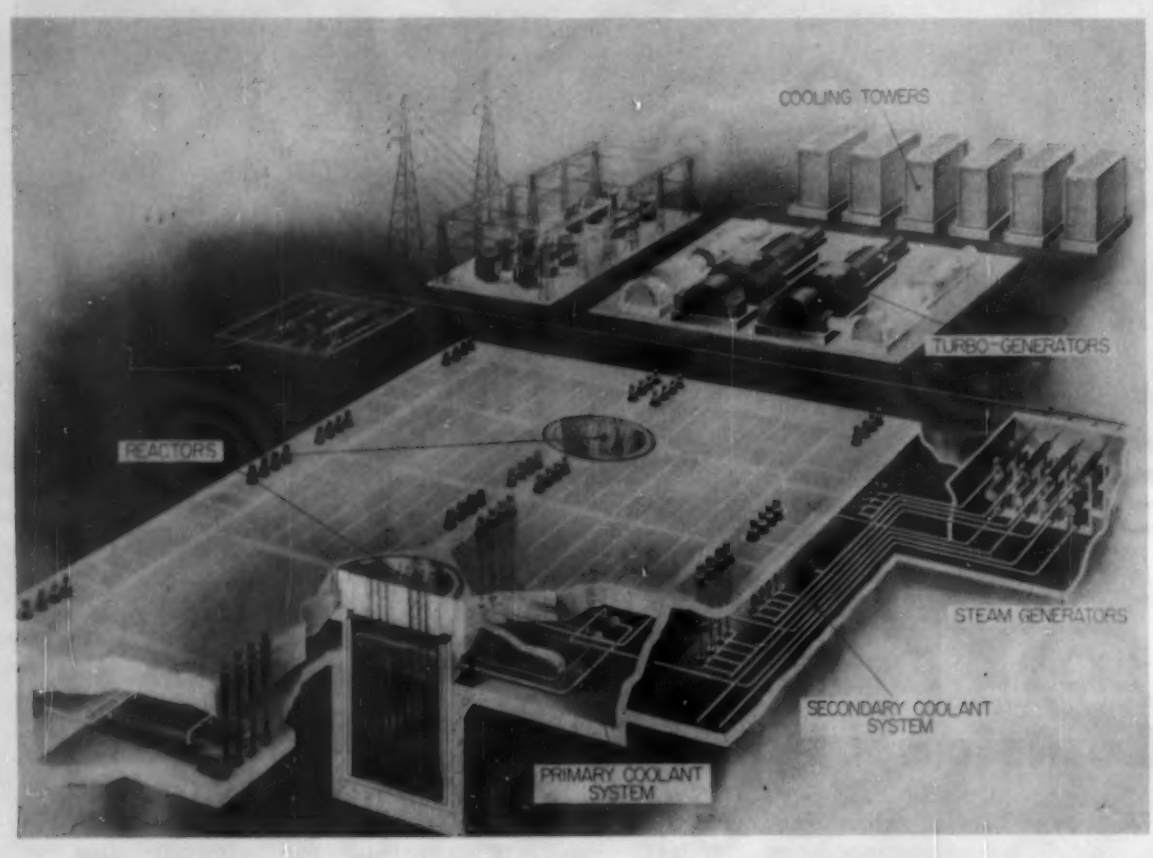
A-4635

ALLIS-CHALMERS

TECHNICAL BRIEFS

Latest engineering developments for busy power men

7 Digests for you on:
NUCLEAR POWER
GENERATORS
HYDRO
STEAM POWER



Sodium graphite reactors make promising bid for nuclear power

Sodium graphite reactor power plants. *By Dr Chauncey Starr, Mgr, Nuclear Engrg & Mfg Dept, North American Aviation, Inc.*

Comprehensive studies of the engineering feasibility, nuclear characteristics and economic potential of many systems for production of nuclear power have been made in the last several years. These show that a promising approach to economical nuclear power is development of high-temperature low-pressure reactor types. A present embodiment of this concept is the sodium graphite reactor (sgr) system.

In a typical nuclear plant, up to three-fourths of the fixed charges per kilowatt hour may depend directly on plant thermal efficiency. Remainder is generally proportional to the total amount of power produced. So there is a greater incentive to achieve high thermal efficiency in a nuclear plant than in a conventional one. Also, there is an equally greater incentive to reduce capital investment in the reactor portion of the plant.

Fluid dynamics of liquid sodium is similar to that of water. A further advantage of sodium is the general absence of chemical corrosion in metal systems, permitting use of a wide variety of steels and other alloys.

Disadvantages include chemical reaction with oxygen and water, and susceptibility of induced activity when exposed to neutrons. The latter creates its most serious handling problem in nuclear power applications.

Engineering development of a sgr reactor and heat extraction system may eventually permit (1) production of steam temperatures limited only by turbine performance, and (2) simplification of the reactor cooling system to an extent approaching low-pressure water systems.

Important features of the sgr system include: (1) High coolant temperature without pressurization of the reactor heat-extraction system permitting good

Why does this packing outwear others in cold liquid service?
Because J-M NAVALON contains and retains more lubricant!
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NAVALON PACKING

...and NAVALON® is made of Ramie, nature's strongest fibre

J-M Navalon gives more value because it outwears other high quality packings in cold liquid service. Made by an exclusive process, it contains more lubricant to start with and retains more lubricant in service . . . resulting in less wear on equipment and longer packing life. Navalon has other unique features, too. It resists rot and mildew . . . its strength actually increases when wet . . . the result: fewer shutdowns for repacking.

That's why Navalon is widely used to seal against fresh or salt water, brine, cold oils . . . and many other cold liquids. It has an excellent record of service on pumps, elevators, accumulators, reciprocating rods and plungers, stern tubes and rudder posts of ships. Available in full range of sizes, in styles 190 and 245 for industrial use, style 175 for marine use.

Your J-M Packing Distributor carries complete stocks of J-M Navalon and other high quality Johns-Manville Packings. He can help you choose the right one for your application. Call him for complete information or address Johns-Manville, Box 60, N.Y. 16, N.Y. In Canada, 199 Bay St., Toronto 1, Ont.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville PACKINGS & GASKETS

More TECHNICAL BRIEFS

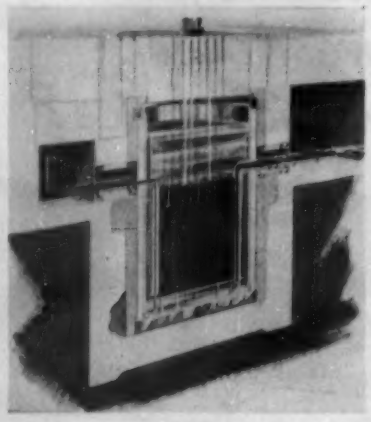
Begins on page 152

Nuclear power

Continued from page 152

steam conditions and high thermal efficiency in power-conversion equipment. (2) Reactor can be adapted to a variety of fuel elements and operating conditions. (3) There are no chemical incompatibilities in the fuel-element-coolant structure combination. (4) Reactor system is inherently safe and its design configuration was chosen to contain radioactivity under all circumstances.

Layout, *p 152*, is for larger central stations having a dual or twin reactor core, rather than a single one. Each reactor has separate controls, piping, pumps and heat exchangers, so either can operate independently of the other. But the same building, loading and unloading mechanism and fuel-storage facilities serve both reactors. This gives higher plant availability than a single reactor installation because plant can run at 50% rating during fuel loading and unloading, or at times of low power demand.



CORE for the sodium graphite reactor

Cost estimates vary from a low of $208 per kw for a twin-core 300-mw thorium unit to a high of $315 per kw for a single-core 75-mw uranium unit. Approximate fuel investment for these same units is $50 and $80 per kw, respectively. With 14% fixed charge rate and an 80% load factor, capital costs range from 4.2 to 6.3 mills per kwhr. Operating and maintenance costs for these plants would probably range from 0.9 to 0.6 mill per kwhr.

Fuel cost, including depletion, reprocessing and fabrication may range from 2 to 2.5 mills per kwhr for uranium and from 1 to 1.5 mills per kwhr for thorium. Costs summarized in the paper indicate a range of 6 to 10 mills per kwhr for this type central-station plant, depending on fuel type, plant size and arrangements made with the government for fuel acquisition. These costs are indicative only of what may be expected from the "first-generation" of plants of this type, based on present information. *APC paper; no number.*

Directions for ordering papers are given on page 210

Application of gas turbines to nuclear power plants. *By H E Grantz and B H Neufer, General Electric Co.*

Four different cycles are considered in this paper: (1) boiling-water reactor and superheating gas turbine (2) open-cycle direct-cooling (3) open-cycle indirect-cooling, and (4) closed-cycle direct-cooling.

These studies show that the topping or superheating cycle apparently will permit increasing the output of a boiling-water reactor to a marked extent for a modest increase in capital investment. This cycle also satisfies the present temperature limitations of the reactor fuel elements. It permits operating the gas turbine independently at its optimum temperature.

Simplest is the open-cycle direct-cooling arrangement. It has the least cost and is best suited of all cycles studied for installation in remote areas where transportation and simplicity are important. But the problem of high fuel-element temperatures must be solved before this type plant can be fully exploited. Potentially serious obstacle is the probable accumulation of foreign material in the core of the reactor, which may be sufficient to impair nuclear reactions.

Indirect-cooled open-cycle provides one means of preventing accumulation of foreign air-borne contaminants in the reactor, if this should be a serious problem. Also, the liquid sodium will tend to protect the fuel elements from excessive temperatures.

Several of these cycles appear to have sufficient potential advantages to warrant further detailed study. To keep initial costs to a minimum, the first experimental considerations of gas turbines will probably be for small packaged power plants. *APC paper; no number.*

Generators

Field preheating for large turbine generators. *By W J Gilson, Jr and H D Taylor, General Electric Co.*

Preheating field windings of large turbine generators is a procedure for warming up and expanding the coils somewhat during the start-up operation by heating them with direct current while the machine is at a relatively low speed. This is done to reduce mechanical stresses in the coils and abrasion effects on coil insulation, resulting from thermal expansion.

This paper analyzes various forces acting on coils in normal service, including a peculiar shortening effect in the cylindrical field body caused by the rotational stresses. It goes on to show how coil stresses and insulation abrasion can be reduced by preheating.

Procedure recommended is based on transient heating characteristics of the rotor, and requires a relatively short period of time, which can normally be coordinated with practical turbine starting cycles. Preheating is easy, with the proper equipment. It gives promise of prolonging the useful life of generator field coils. *AIEE paper no. 54-447.*

Operation of hydrogen-cooled turbine generators. *By C C Sterrett and R A Towne, Westinghouse Electric Corp.*

Hydrogen-cooled generators constitute the major portion of the nation's present generating capacity. Their proper operation is necessary to assure service continuity and protect the large capital investment in generating equipment. Continuous advances in generator design have made it necessary for manufacturers and operators to re-examine operating practices regularly.

Early hydrogen-cooled generators, put on the line in the late 30s, operated with 0.5 psig hydrogen pressure. Generally base-load units, they were operated according to the same practices developed over the years for large air-cooled generators. As generator physical size increased, to meet the demands for individual units of higher ratings, higher hydrogen pressures were used.

The larger units were usually based-loaded, with older generators assigned peak-load operation, subjecting them to

(*Continued on page* 208)

Ljungstrom® field engineers assure you of maximum return on your preheater investment

Your Air Preheater Corporation field engineer aims to visit your installation at least once a year. It's his job to give you the help and advice you need to assure you of maximum return on your Ljungstrom Air Preheater investment.

This field service is another factor in making the Ljungstrom the most economical heating surface on the modern boiler. And it helps explain why 7 out of 10 modern preheater installations are Ljungstroms.

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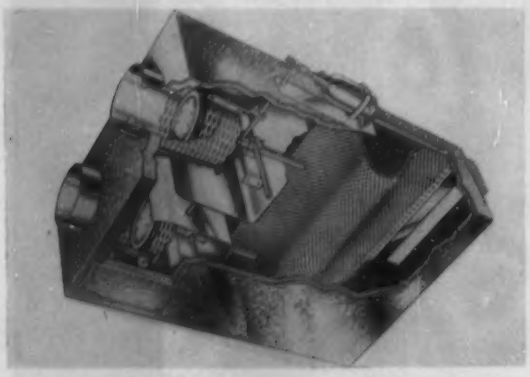


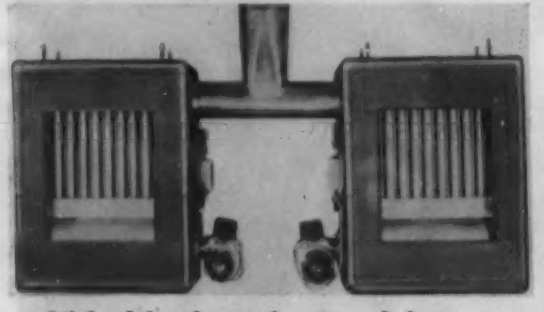
Dual-duct, high-pressure air diffusers

706 • Temperature and volume are controlled separately in this dual-duct, high-pressure air diffuser. While total air delivery, once established, remains uniform under all operating conditions, temperature is varied by mixing hot and cold air quantities.

Both air inlets are fitted with dampers consisting of double perforated concentric sleeves and felt edged pistons. Two outer sleeves slide back and forth over fixed inner sleeves, governing size of holes through which the air flows. Adjusting the pistons changes number of perforations accessible to air flow and hence determines total air delivery. As each piston is adjusted separately, hot and cold air supply may be closely regulated against different static pressures in each duct.

Unit is made in capacities to 1000 cfm, operating at static pressures to 6-in., water gage. Complete data in bulletin K-33.

Connor Engineering Corp, Danbury, Connecticut



Oil-fired duct heater for air-cooled systems

707 • Oil-fired duct heater is designed for use with industrial and commercial air-cooled systems. Five sizes are available ranging from 110,000 to 220,000 Btu per hr output. Heaters can be teamed-up in tandem, as shown above, when higher outputs are needed.

The heater is used to provide a direct oil-fired unit when the air-moving blower is part of the air conditioning system. It is also applied as a makeup fresh air heater in foundries and industrial buildings, wherever large quantities of air are exhausted. Complete information in catalog DHUH available on request to the manufacturer.

Certified Furnace Corp, Box 1059, Trenton 8, N. J.

Absorption refrigerating machines

708 • Absorption refrigerating machines, designed with no major moving parts, produce chilled water from hot steam. They are available for large-capacity air conditioning and process cooling installations in a range of 11 sizes from 100 to 700 tons. The units will adjust automatically from full down to virtually zero load with little loss in efficiency, manufacturer states. Further, they are designed to produce low-cost cooling wherever an economical source of heat such as natural gas is available.

They are also suitable when a source of steam is already available from the heating boiler, as a by-product of a process using steam, or from district steam lines. Since the machine operates on low-pressure steam, that may also be obtained from back-pressure turbines or exhausted from various processing operations, it can provide chilled water for summer air conditioning or process chilling at little operating cost, according to manufacturer.

The machine may be installed on roofs of buildings without special reinforcing or bracing. Its vertical assembly facilitates installation at floor levels or in basements. Details on request.

Carrier Corporation, Syracuse, New York

Aluminized pipe jacketing is acid-resistant

709 • Aluminized pipe jacketing is resistant to fire, acid and water, manufacturer states. Made of aluminum foil laminated onto vapor-proofed asbestos cloth, it can be used to cover pipe insulation in heating, piping, refrigeration and air conditioning systems in electric utility and industrial plants, commercial and institutional buildings. Called *Asbeston* pipe insulation jacketing, it requires no painting, according to manufacturer.

Asbeston is easily cleaned and does not absorb odors, making it suitable for food processing plants and laboratories.

U.S. Rubber Co, Rockefeller Center, New York 20, N. Y.

Temperature control for pneumatic systems

710 • This control is designed for use on all installations where temperature is to be controlled by varying flow of gas, steam or other medium with an air-operated valve or motor.

It may be used in any pneumatic system up to 50 psig and will reduce output or branch line pressure as temperature increases. Since it operates by differential expansion of solids and uses no liquid or vapor fill, it is available for temperatures to 1800 F.

Temperature adjustments are made with knob on front of case. Throttling ranges are fixed, but may be specified as narrow as 5 deg or as wide as 100 deg. Control is obtained by difference in expansion of two concentric tubes actuating a pilot valve through a lever. Request bulletin 151.

Burling Instrument Co, 16 River Rd, Chatham, N. J.

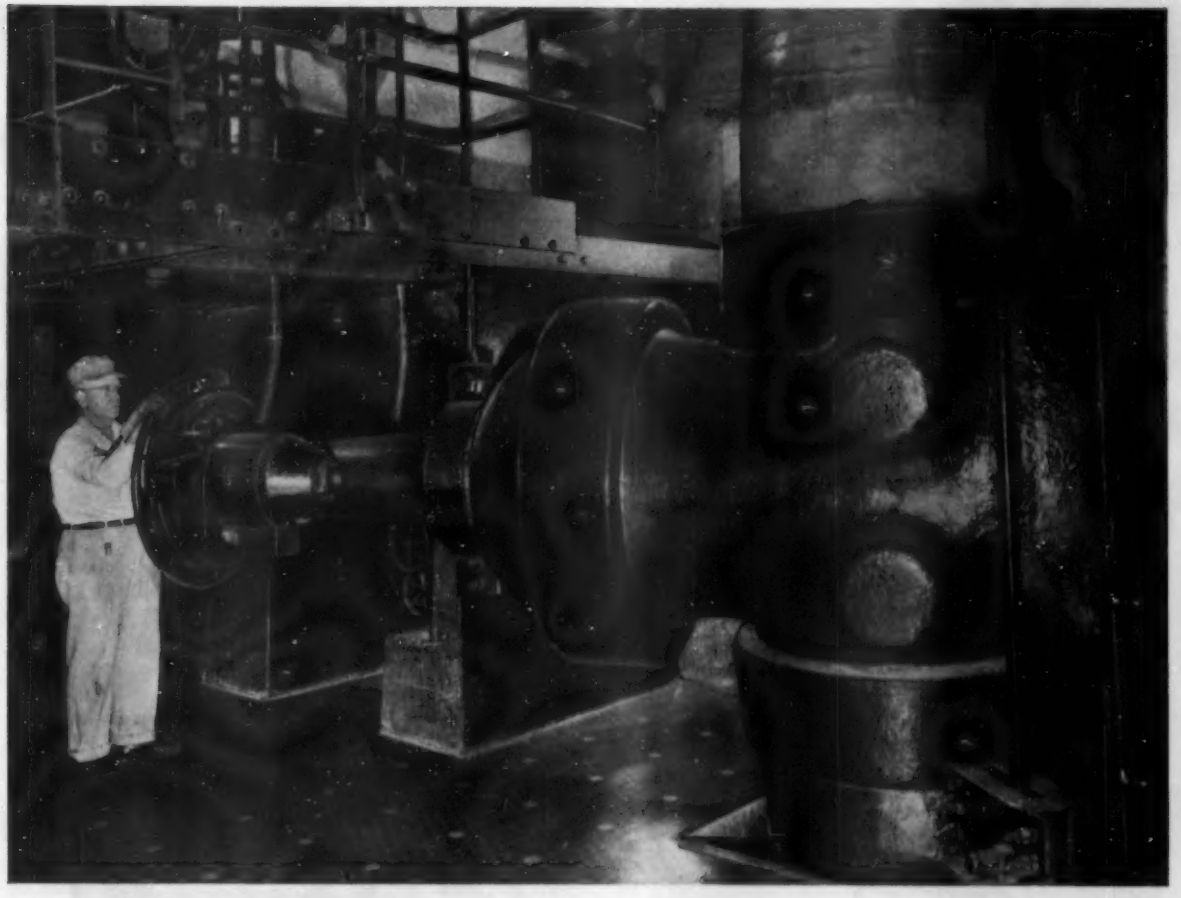
Paper thermometers for use at 100 to 470 F

711 • *Thermotubes* are a graded series of sealed-in-glass temperature indicators that change appearance irreversibly from white to black at predetermined temperatures. Accuracy is ±1% of stated temperature, according to manufacturer.

In use, a *Thermotube* is placed at any location within any object whose temperature is to be read. It will show a sharp white to black color change when surrounding temperature equals or exceeds rated *Thermotube* temperature.

The Paper Thermometer Co, 10 Stagg Dr, Natick, Mass.

For more data on these items, use postcards, page 165. Identify your request with item number.



Dividends from this Crane valve over 30 years... 6¾ billion kilowatt-hours

Over thirty years ago, this 30-inch Crane steel gate valve was put in service at Commonwealth Edison's Crawford Station in Chicago.

As of May, 1955, unit No. 1 on which this motor-operated valve is installed, had been in operation more than 150,000 hours. Total power output generated with this valve in service was approximately 6,750,000,000 kilowatt-hours.

The valve is on reheat steam service with working conditions of 100 psi. at 700 degrees F. Never out of the line, and given but routine maintenance attention since installed in 1925, the valve's performance remains completely satisfactory.

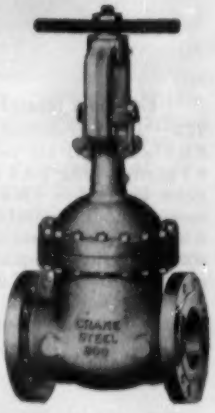
Seating action is positive and tight; bonnet-joint and stem seal are tight; operation is smooth.

There is nothing special about this rising stem, cast carbon steel valve—nothing but its dependable Crane quality. Development of steel valve castings was pioneered by Crane; long life and low maintenance are deeply rooted characteristics of Crane valves.

In steel valves, as in other materials, the Crane line is most complete: gates, globes, angles, checks and stop-checks—bolted, Pressure-Seal, and Lip-Seal bonnet designs—screwed, flanged, or welding ends—sizes up to 24 in.—pressure classes up to 2500 psi.

Your Crane Representative can give valuable help in specifying and ordering.

Crane Co., General Offices, Chicago 5, Ill. Branches and Wholesalers serving all industrial areas.



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CRANE'S FIRST CENTURY...1855-1955

More EQUIPMENT NEWS

Begins on page 156

Developments of timely interest to the electrical field

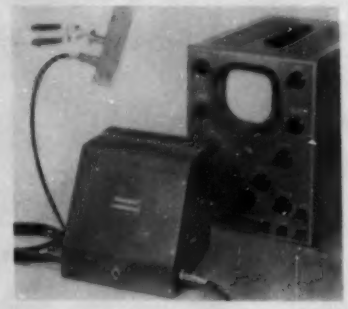
High-voltage motor control

726 • *Limitamp* control is said to save more than 50% in floor space over previous models. A high-voltage fused starter for coordinated control of motors to 3000 hp on 2300- to 4800-v systems, *Limitamp* unit offers better protection against circuit faults to 60,000 amps, according to company engineers. Designed to give maximum short-circuit protection, fuses of high interrupting capacity limit current flowing in a fault within ¼ of a cycle and interrupt within ½ cycle, manufacturer states.

Units are only 30-in. deep. Being all front connected, *Limitamp* controls can be mounted back-to-back or back-to-wall. No back aisle is required.

A low-voltage panel in middle compartment swings out and high-voltage contactor in lower compartment rolls completely out of enclosure. This makes it possible for installing personnel to stand inside cabinet. Request details.

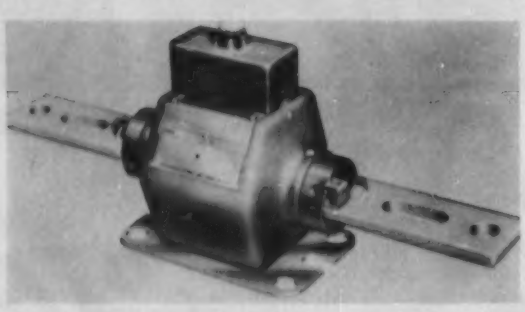
General Electric Company, Schenectady 5, New York



Safety-type corona tester

727 • This detector determines presence of corona in high-voltage rotating apparatus. Unit consists of probe mounted on end of insulating pole, control unit and necessary cables. In use, control unit is connected to a standard oscilloscope that gives visual indication of the corona. Bulletin 17.

Sunshine Scientific Instrument, 1810 Grant Ave, Philadelphia, Pa.



Current transformers for 600-v service

728 • Polyester-molded outdoor current transformers, *Types EMR* and *EMO* are designed for 600-v service. They have 0.3 accuracy with B-0.1 and B-0.2 burdens, and have a rating factor of 2. *Type EMR*, shown above, has a round primary opening and is supplied in 200/5- and 400/5-amp ratings. The *EMO*, with an obround opening, is supplied in 200/5-, 400/5-, 600/5- and 800/5-amp ratings. Both units are available with or without silver-plated, flat-terminal primary bars, 11⅞-in. long. A round primary bar, 10¼-in. long is supplied only with *Type EMR*. Details on request.

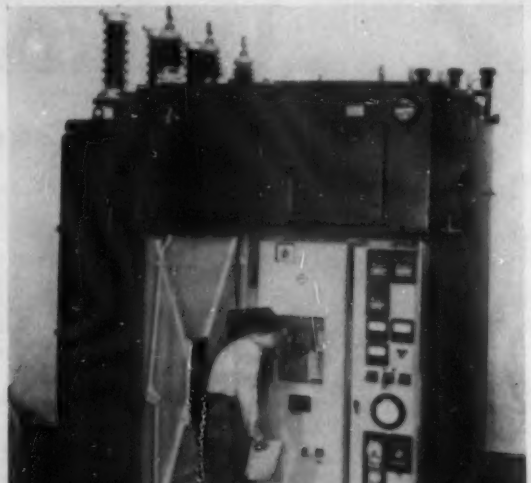
Westinghouse Electric Corp, Box 2099, Pittsburgh, Pa.

Plug-in fusible distribution switchboards

729 • Units are designed for use in commercial and industrial applications where grouping of power distribution equipment is desirable. Furnished in standard ratings from 30 to 600 amps, 2 and 3 pole, they are hp rated for both standard NEC and dual element fuses. Units are available for 250-v ac or dc and 600-v ac.

Plug-in construction allows all units through 200 amps to be plugged onto the bus bars. The 400- and 600-amp units are bolted directly to the bus. Complete details on request.

Square D Co, 6060 Rivard St, Detroit 11, Mich.



Redesigned single-circuit substations

730 • Redesigned substations have a low voltage of 5 kv or less to permit easier handling and greater convenience in operation, manufacturer states. Meters, recording instruments and control panels are located in a safe, dead front compartment, making them easily accessible.

Standard bus structure and arrangements for either 50 or 150-mva units enable users to modify equipment for higher breaker ratings. Panel sizes have been standardized and a single arrangement permits inclusion or omission of the by-pass switch. Full details on request to manufacturer.

Allis-Chalmers Manufacturing Co, Milwaukee 1, Wis.

To obtain more information on these new equipment items, use postcards on page 165. Identify your request with item number.

From this control panel in a typical processing area, a Johnson Record-O-Stat maintains and records constant wet and dry bulb temperatures. Water bottle, blower and motor are mounted below the Record-O-Stat. The air conditioning system at Greenville Mills is estimated to be the largest in Mississippi.

From raw wool to finished carpets—that's the story of the new Greenville Mills plant of Alexander Smith, Inc. Closely controlled temperatures and humidities, both for worker comfort and to safeguard sensitive processes, are essential to the efficiency of this modern plant. To maintain the exact conditions required in each area of the building, Greenville Mills depends on a specially designed system of Johnson Control. Here's how it works:

PROCESSING AREAS

Processing areas are divided into eight zones—carding, spinning, twisting, reverse twisting, setting and threading, weaving (2), and finishing. Conditioned air is supplied by from one to four air handling units per zone. Accurately controlling the temperature and humidity in each zone is a Johnson T-1020 Two-Pen Record-O-Stat which maintains and records constant wet and dry bulb temperatures.

Each Record-O-Stat operates a Johnson Three-Way Mixing Valve on the chilled water coils, Johnson V-103 Steam Valves on the steam reheat coils, and a Johnson V-105 Steam Valve on the grid humidifier on each of the air handling units. To insure accurate response under all conditions, all valves are equipped with Johnson V-510 Pilot Positioners.

For quick warm-up, hot water can be circulated through the cooling coils. A single, convenient switch provides the changeover.

SMOKE CONTROL FEATURE

A system of smoke dispersal is necessary in this windowless building. If smoke is detected in any unit, the return air damper automatically closes and the maximum outdoor air damper opens, increasing pressure inside the building and forcing the smoke out gravity roof ventilators. A manual switch at each control station will provide 100 per cent outdoor air at anytime.

OFFICES

Ideal temperatures in offices and other comfort areas are maintained by Johnson Individual Room Thermostats which regulate the supply of conditioned air from multi-zone air conditioning units. During the heating season, Johnson Master-Submaster Control automatically varies the heat supply in accordance with outdoor temperature.

OTHER SPACES

Other areas controlled include the laboratories, where control arrangements are similar to those in the processing sections. In the loading and stocking areas, strategically located Johnson Room Thermostats provide the desired temperatures by controlling Johnson Valves on ceiling-hung steam heating units.

Tens of thousands of buildings, of all types and sizes, depend on Johnson Control for the precision regulation of temperatures and humidities. In every case, simple or complex, the Johnson System is specifically designed to fit the exact needs of the individual building. Next time you have a problem, ask a nearby Johnson engineer for recommendations. There is no obligation. JOHNSON SERVICE COMPANY, Milwaukee 2, Wisconsin. Direct Branch Offices in Principal Cities.

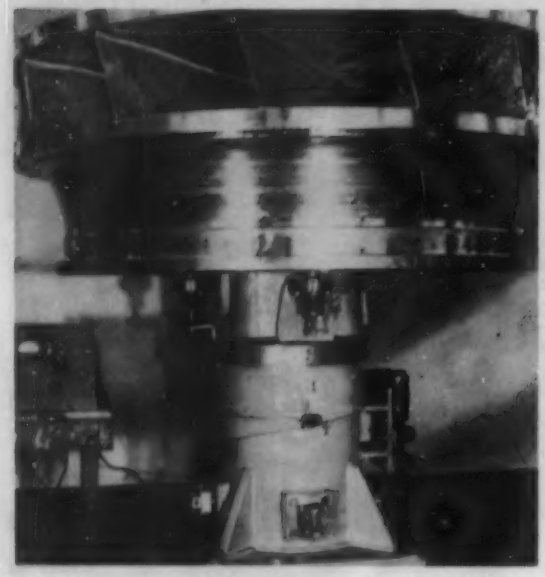
*Greenville Mills, Inc., Greenville, Miss. (a division of Alexander Smith, Inc.). Mallett & Associates, architects and engineers, Jackson, Miss.; James F. O'Neil Co., heating and air conditioning contractor, New Orleans, La.

JOHNSON CONTROL
TEMPERATURE AIR CONDITIONING

PLANNING • MANUFACTURING • INSTALLING • SINCE 1885

More EQUIPMENT NEWS

Begins on page 156



Balancer handles equipment to 250,000 lbs

701 • Balancing machine provides a ready means for accurately detecting static and dynamic unbalance in runners, rotors, flywheels and other rotating equipment. It is available in three sizes with maximum capacities of 10,000, 100,000 and 250,000 lbs. Unit consists essentially of a heavy support frame and a turntable that can be rotated between 10 and 20 rpm. Photo above shows a *Model 100* balancer handling a 7500-lb Francis turbine runner.

Turntable is carried on a weighing shaft supported by heavy rolling-contact bearings. Weighing shaft is positioned on lower end by four roller assemblies—two fixed and two pre-loaded by compression springs. Unbalanced forces are transmitted by weighing shaft through roller assemblies to leaf springs and thence to the strain gage element of the electronic amplifier.

The Pelton Water Wheel Company, 2929 19th Street, San Francisco, California

Testing-station checks all types of valves

702 • Semi-portable valve-testing station will test any size safety valve. All other type valves including globe, gate, plug cocks, etc, can also be tested by means of an integral floor manifold unit. Manufacturer states that unit can eliminate need for valve repair work by outside shops since test stand not only checks out new valves but provides for fast processing of maintenance valves. Floor testing is provided for large and heavy valves.

The packaged unit is ready to operate once water, air and electrical lines are connected. Helium, nitrogen and other compressed gas testing is provided as optional equipment.

Unit contains air tanks and compressors for pressures to 500 psi. Air-powered booster pump with 60:1 ratio furnishes hydraulic pressure to 6000 psi. Complete data on request.

Farris Engineering Corporation, 627 Commercial Avenue, Palisades Park, N. J.

For more data on these items, use postcards, page 165. Identify your request with item number.

High-frequency generators

703 • Standard units include 30, 50 and 100-kw motor generator sets and 25 and 50-kw vacuum tube induction or dielectric generators. The motor generators and the 50-kw power supply cubicle may be located remote from the load station cubicles. All cubicles are only 36-in. wide and may be fully opened on two or three sides for servicing. Motor generators are used to generate frequencies to 9600 cycles per second and vacuum tubes for 450 kc to 40 mc.

Water-cooled motor generators, tubes and high-voltage *Askarel*-filled transformers are used wherever feasible to insure adequate cooling. Automatic protection is provided in case of water failure or overload. All designs conform to NEMA and AIEE standards.

New Rochelle Tool Corp, 322 Main St, New Rochelle, N. Y.

Submersible motor

704 • Submersible motor is of the "wet" type construction. Copper windings are encased in plastic similar to that used to jacket submerged power cables. The plastic is a high dielectric compound that has extremely low water absorption. Manufacturer states that motor is immune to leaky joints, wear of seals, condensation, vibration, impurities, etc.

Unit is filled with highly stable emulsion of oil and water. The oil particles have a polar attraction to metal surfaces and deposit on them, preventing corrosion. Motor is available in ratings from 1/3 to 2 hp, single phase, and 1½ and 3 hp, three phase. Request bulletin F-1870 for details.

U.S. Electrical Motors, Inc, Box 2058, Terminal Annex, Los Angeles 54, California

All-weather pipe wrap tape

705 • Polyvinyl chloride pipe wrap tape features increased adhesion and conformability even at freezing temperatures, according to manufacturer.

The plastic tape is an improved version of the firm's *Scotchrap* pipe insulation and is stated to be the first pressure-sensitive pvc tape formulated exclusively for pipeline corrosion prevention. Two tapes are available—*Scotchrap* pipe insulation No. 50 which is 10-mils thick for use in wrapping fittings and wherever maximum conformability is necessary, and No. 51 which is 20-mils thick for straight-run wrapping. Rolls are available in 100-ft lengths and in widths of 1, 2, 6, 8 and 12-in. Further information may be obtained on request to manufacturer.

Minnesota Mining & Mfg Co, Dept E-584, St Paul, Minn.

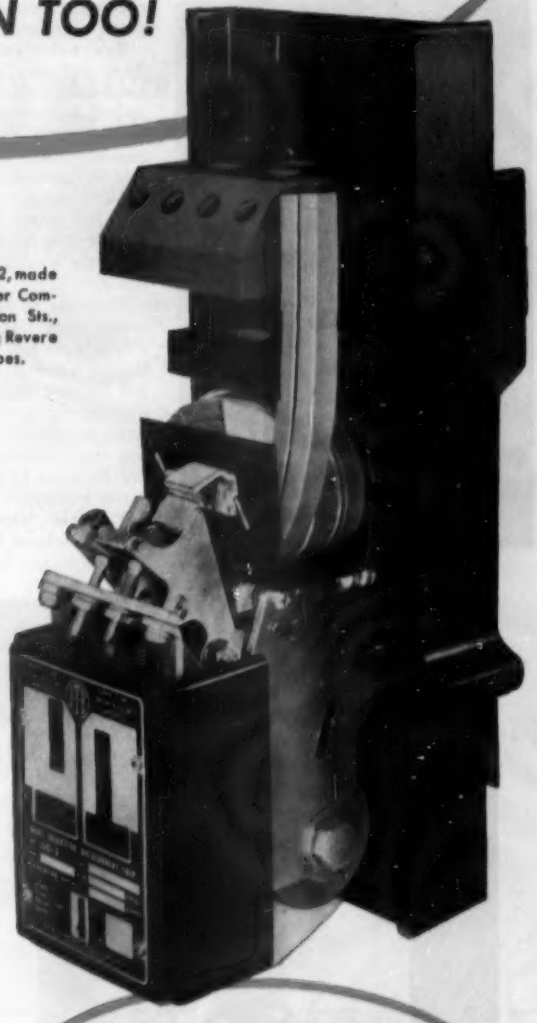
I-T-E

SAVES MONEY BY USING

Revere Extruded Shapes

PROBABLY YOU CAN TOO!

Actuating mechanism, showing overload coil brazed to two Revere Extruded Shapes.



Overload device, OD-2, made by I-T-E Circuit Breaker Company, 19th & Hamilton Sts., Philadelphia, Pa., using Revere Copper Extruded Shapes.

Here is a photograph of the I-T-E Dual Selective Overcurrent Trip, an air circuit breaker part. It contains two Revere Extruded Shapes, in copper. In the detail view, the beveled shape at the top is furnished in Free-Cutting Copper, to speed up the drilling and tapping of the holes. The piece below it was originally milled from rectangular copper bar, 1 x 2 inches. The bar weighed 7¾ lbs per foot, and 1.8 lb of scrap per foot was generated in machining it to the angular form shown. The company then switched to a Revere Extruded Shape, weighing a little less than 6 lbs per foot. Though the shape inevitably costs more per pound than the bar, the reduction in weight was sufficient to save almost 44¢ per foot over the bar, and of course additional savings were realized in reduced machining time and in scrap handling. Production also was speeded up. This is an outstanding example of the economies offered by shapes.

Look into extruded shapes, in copper and copper-base alloys, and aluminum alloys. The nearest Revere Sales Office will be glad to explore the subject with you.

REVERE

COPPER AND BRASS INCORPORATED

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230 Park Avenue, New York 17, N. Y.

• • •

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N.Y. Sales Offices in Principal Cities; Distributors Everywhere.

More EQUIPMENT NEWS

Begins on page 156

Two items for improved water treatment

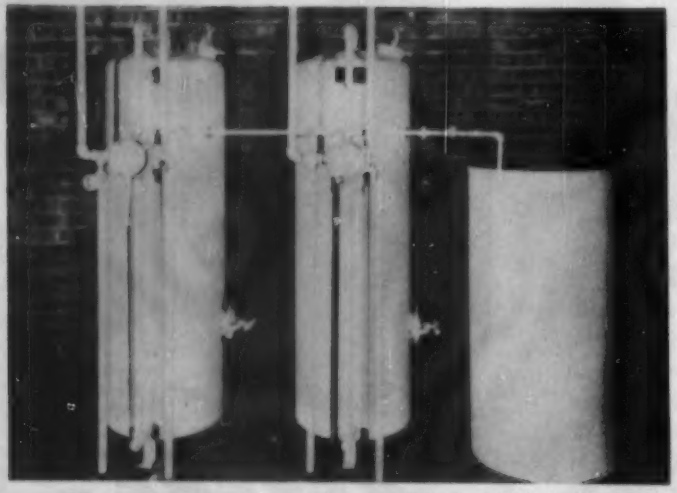
Automatic demineralizing unit

721 • Completely automatic mono-column demineralizer is designed for users of 200 gph of super high purity water. Only installation requirements are connection of influent to plant's water system and connection of effluent to points where high purity water is needed.

Raw water enters demineralizer at influent and after passing once through the mono-column of mixed cation and anion resins, is received at effluent stripped of impurities. A flow meter on the influent enables setting water intake at optimum rate for most efficient ion exchange action. A purity meter plus automatic controls enable full control of effluent purity. Thus, all operating functions, including regeneration cycle, are fully automatic, manufacturer states.

There are no valves to operate and minimum supervision is required. Whenever effluent's conductivity falls below standard, treated water is automatically discharged and warning signals indicate need for activation of regeneration cycle. Turn of a single switch puts unit through its regeneration cycle automatically, including rinsing and recutting in the effluent when desired purity is reached. Catalog on request.

Penfield Manufacturing Co, 19 High School Ave, Meriden, Conn.



Zeolite water softeners for small industrial plants

722 • Small zeolite water softeners are made in 13 standard sizes with flow rates from 6.5 to 40 gpm. Designed for convenient operation through a single multiport valve, they can be supplied with either automatic or semi-automatic controls.

In automatic operation, the steps of backwashing, brining, rinsing, and return to service are carried out without operator's attention. With semi-automatic operation, initiation of regeneration cycle is controlled by push button.

The units will satisfy demands for small volumes of soft water in food and processing plants, power plants, commercial and institutional laundries. Bulletin 210.

Industrial Filter & Pump Mfg Co, 5900 Ogden Ave, Chicago, Ill.

Submersible water pumps

723 • High - capacity submersible pumps are designed to meet freshwater supply requirements for general plant facilities as well as such auxiliary services as fire fighting, air conditioning and cooling, processing, etc. The pumps are available in capacities to 200 gpm and will operate at total dynamic heads up to 450 ft in 6 and 8-in. diameter wells.

General construction consists of a direct, close-coupled centrifugal pump and motor unit. Entire pump and motor assembly is lowered down the well on end of discharge pipe and operates under water. Motor is available in 3 to 15-hp ratings.

Pumping unit consists of bronze centrifugal impellers operating in high-efficiency bronze pump bowls. It can be supplied in 4 to 12 stages. Full details in bulletin B1000.

Sumo Pumps, Inc, 308 Atlantic Street, Stamford, Connecticut

Differential float valve

724 • Unit is used where fast-acting full off-and-on control is required. It is recommended for control of ejector or motor-driven pumps where a pressure switch is used. It eliminates seepage and short cycling of pumps, manufacturer states. The valve may also be used to maintain liquid levels in tanks.

Minimum differential maintained is 12 in. Further details on request.

Klipfel Valves Inc, div of Hamilton-Thomas Corp, 1075 Lincoln Ave, Hamilton, Ohio

High-pressure check valve

725 • This check valve is designed for 0 to 10,000 psi range. Floating poppet design is not affected by foreign particles in the fluid and eliminates "wire drawing" across the seat, according to manufacturer. Spherical metal seat is said to assure perfect seating and support for O-ring that serves as a sealing member and absorbs closing shock.

James-Pond-Clark, 2181 E Foothill Blvd, Pasadena 8, Calif.

For details on these items use post cards p. 165. Identify request with item number.

CHECK THESE TOO . . .

Ball bearing unit . . . . . p 170
Pneumatic switches . . . . . p 172
Enclosed fluid drives . . . . . p 172
Motors, equipped with outside starting switch . . . . . p 174
Diaphragm control valve . . . p 174
Hydraulic handling device for heat exchanger tubes . . . p 176
Gas-fired unit heaters . . . . . p 176

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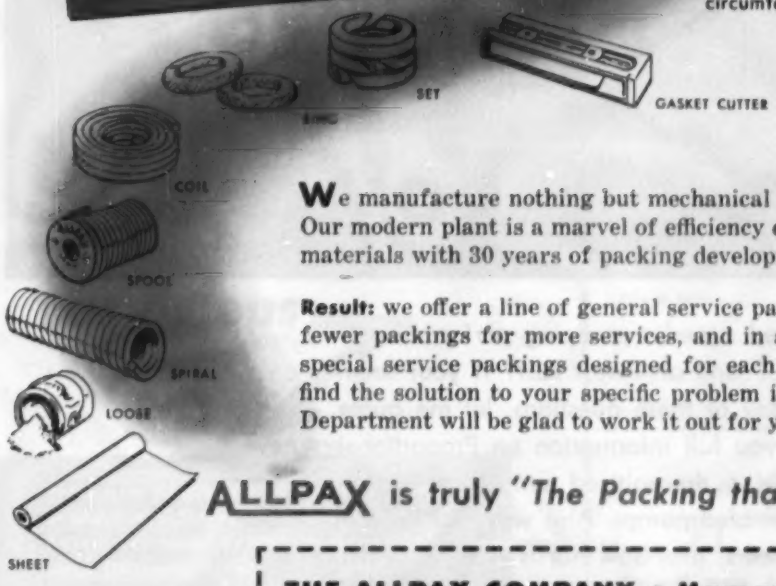

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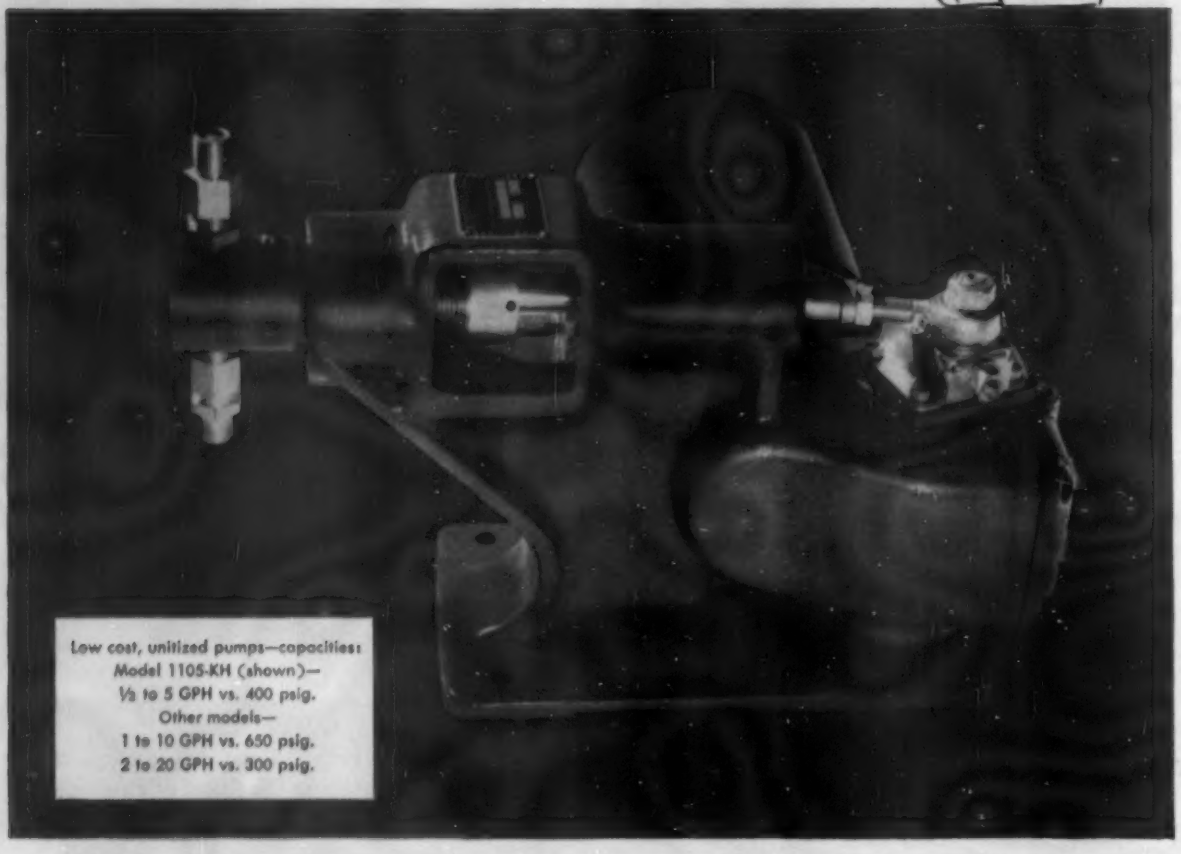
Low cost, unitized pumps—capacities:
Model 1105-KH (shown)—
½ to 5 GPH vs. 400 psig.
Other models—
1 to 10 GPH vs. 650 psig.
2 to 20 GPH vs. 300 psig.

Do you need superior pumping performance? Need it now? . . . and at lowest cost? If your answer is "yes" to any of these questions, let me quote.

I'll give you full information on Proportioneers new Model 1105-KH . . . the unitized pump that costs no more than assembled pumps. Also write for Bulletin 1100-M1.

Proportioneers, Inc., 354 Harris Ave., Providence 1, R. I.

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AIR CONDITIONING, REFRIGERATION, HEATING AND VENTILATING

1 **High-pressure air diffusers.** Illustrated 48-p bulletin contains data on where air transmission may be used to advantage, engr considerations, single and dual duct designs, typical layouts, velocity and pressure factors, duct sizing and construction, sound control and other info of value to air conditioning, heating and ventilating engineers. Bulletin K33. Connor Engineering Corp, Danbury, Conn.

2 **Power room exhausters.** Axial mushroom units, designed for wherever roof ventilation is applicable, either with or without duct systems. Detailed info and performance tables in illustrated bulletin CAM-102. Chicago Blower Corp, 9869 Pacific Ave, Franklin Park, Ill.

3 **General purpose fans.** Portable, self-contained units of medium capacities for ventilating and industrial use. Photos, material specs, capacity tables, dimensions in 12-p bulletin 545. The New York Blower Co, 2155 S Shields Ave, Chicago 16, Ill.

4 **Rotary blowers** provide air or gas for many special applications including: air for agitation or aeration, cooling or ventilation, pneumatic conveying, etc. Specs, capacity curves, performance data on units with blower pressures to 15 psig or higher in stages; vacuum to 15-in. Hg; capacities to 4000 cfm. Bulletin 255. Michle-Dexter Supercharger div, Dexter Folder Co, Racine, Wis.

5 **Industrial and commercial heating** is theme of new house organ entitled "Pyroscope." First and subsequent editions are available on request to Preferred Utilities Manufacturing Corp, 1860 Broadway, New York 23, New York.

6 **Injector burners** for high-pressure gas is subject of 2-p bulletin H-62T. Contains data on dimensions, capacity charts, diagrams. Eclipse Fuel Engineering Co, 1001 Buchanan St, Rockford, Ill.

7 **Dehumidifiers**—water cooled, Freon-cooled, compressed air and sorption units are detailed in illustrated bulletin R-11. Contains data on moisture load calculations, applications for systems described. Desomatic Products, Inc, 1109 W Broad St, Falls Church, Va.

BOILERS AND AUXILIARIES

8 **Dowtherm vaporizers** are fully described in 6-p bulletin containing photos and diagrams. Includes data on features and applications of the liquid heating unit that operates safely and continuously at 750 F. The International Boiler Works Co, E Stroudsburg, Pa.

9 **Ash gate and feed housing units are subject** of 4-p data sheet 004a. Construction and operation data on use to control ash discharge openings in hydraulic type bottom ash storage hoppers are presented. The Allen-Sherman-Hoff Co, 359 E Lancaster Ave, Wynnewood, Pennsylvania.

10 **Combustion control system** for package boilers. Fully automatic, electrically operated steam pressure regulator houses all elements in a single case. Two-page bulletin E-102 gives outstanding features, full specs. Reliance Instrument Manufacturing Corp, 199 Glen Cove Ave, Glen Cove, L. I., N. Y.

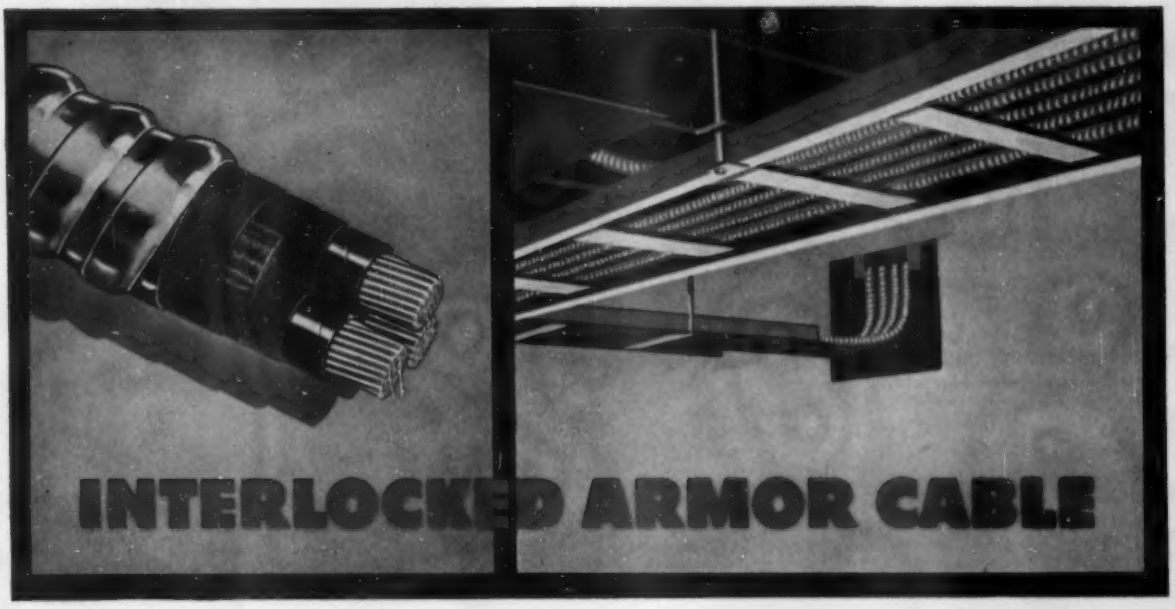
11 **Water gages and valves** for boiler water service are described in 2-p data sheet 245A. Photos, capacities, specs. Jerguson Gage & Valve Co, 80 Fellsway, Somerville, Mass.

12 **Steam power specialties.** Illustrated 8-p bulletin contains dimensions, capacities of oil and steam separators and features of various traps. Bulletin 455. Illinois Engineering Co, 2035 S Racine Ave, Chicago 8, Ill.

13 **Mineral oils** for thermal liquid heaters. Photos, diagrams, full descriptions in 4-p bulletin. The International Boiler Works Co, E Stroudsburg, Pa.

(*Continued on page 212*)

THE GREATEST NAME IN ELECTRICAL WIRE AND CABLE



Where extraordinary mechanical protection is required, any type of cable can be armored. General Cable offers this complete range of interlocked armor types:

Armor: copper, aluminum, bronze and steel. **Insulation:** varnished cambric, rubber and thermoplastic.

THE RESULT: a lightweight, flexible Interlocked Armor Cable that is ideal for wiring in close areas...under, down and around beams and pillars...where power needs vary...where plant layout presents space difficulties. Right angle bends, long runs and close quarter installations are easier to make and cost less than conventional cable and conduit.

To cut installation time and cost in new construction or old...Interlocked Armor Cable is used for primary or secondary feeders, and for connecting low-voltage plug-in bus and power utilization equipment.

From conductor to armor...General Cable offers you the ultimate in proven-in-use power and control cables...QUALITY that pays off in DEPENDABILITY, SAFETY, and EXTRA LONG LIFE.

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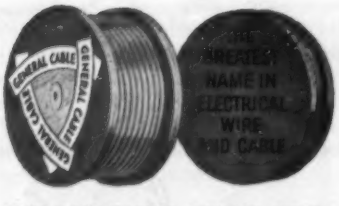

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George Edwards' Scrapbook

Spotting operators

Selecting men to operate and maintain power services (steam-diesel, electrical, refrigeration, air-conditioning, compressed-air, pumping systems, etc) seems to be a constant problem. My mail usually contains letters asking how to tell a good potential operator or maintenance man when I see one.

The answer is that first of all your prospect must *like* machinery. I've found in years of working in plants that unless a person likes to tinker with things mechanical, he usually should not be in the operation or maintenance end. He may make a good engineer if he has the proper schooling. Many boys, who are all thumbs when working with tools, do turn into excellent mechanical engineers. All I'm saying is that if a man is to operate and maintain machinery, being mechanically inclined is the *first* requirement. Reason is that too many things come up in a practical situation with equipment that you can't find in books—there are too many variables. Such problems call for common sense and a natural understanding.

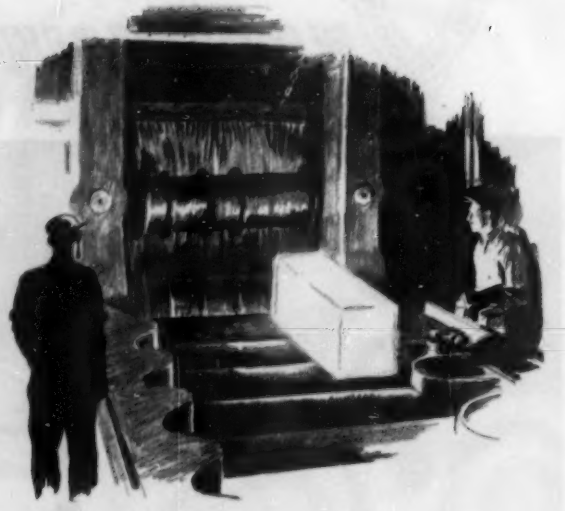
Fact is some of the best operators I've worked with had little formal education. But give them a wrecked machine and before long it is working. Such a person's satisfaction comes from keeping machinery in operation by making new parts, squirting the right drop of oil in the right place at the right time, and knowing just how much to open a valve to get the machine to work as it should.

Too often boys with a degree won't be satisfied for long on such a job. It's an ideal first step for graduates who plan continuing in the power field—if their sights are set on a plant superintendent's job, for example. These men want to work behind a desk, which is natural. On the other hand, operators usually like to get their hands dirty. They get pleasure in fixing things. My answer is to hire a man who is mechanically inclined, then suggest training courses and work with him until he understands his plant.

You'll find many a good potential operator running a drill press, shaper or some other machine tool in your plant. Chances are repetitive production work bores some to the point of quitting. If you talk with these men, you may find they will jump at the chance of getting into maintenance or operation where every job is a challenge.

You are the company

Did you ever stop to think that from the customer's point of view *you* are the company? You're the person he deals with. So that makes you more important than the president—for he knows only you. Don't lose business for your firm by being anything but as considerate of your customers as the head of your firm would be.



Refining counts

Slab of steel shown in this picture is worth about $50 as it is. But if this steel is made into railroad tracks, it will be worth about $200. Make it into needles, and they will bring close to $8000. If processed into watch springs, this same raw material will be worth about $250,000.

These figures may be a little off, but they come pretty close. At any rate, the point I'm trying to make still holds. It's the product we work this material into that makes the tremendous difference in worth.

Getting more personal, chemical content of your body is worth 98 cents. And that goes whether you are the president of your firm or the janitor. But the way you use your 98 cents worth of chemicals makes the difference in your success in life. Most of us can make a much better job of ourselves than we are now doing. We can remain a hunk of raw material, or we can do some refining and become a highly useful finished product. It's up to us.

College to job

1. Begin study of the 40,000 occupations while a freshman.
2. Pinpoint field that suits your interests and abilities.
3. Gain tryout experience by working part time and summers in your chosen career.
4. Start job hunting early in senior year.
5. Learn to type by the touch system. This is useful in handling correspondence, then in making reports when you land a job.
6. Present yourself attractively and honestly in your writing and in interviews.
7. Get help of relatives and friends, send direct applications, use private employment agencies and answer advertisements.
8. Use college faculty, college testing services and placement offices. They are ready and want to help you.
9. Be willing to go where there is a career. Best openings are often far from home.
10. Once you get a job, nail it down by doing it well.

George Edwards
Engineer

CONDENSER VACUUM INCREASED 1.7 INCHES IN 13 HOURS

DOWELL chemical cleaning boosted heat transfer efficiency 25 per cent

An iron oxide scale $\frac{1}{16}$ of an inch thick had seriously cut the efficiency of a surface condenser in this company's power plant. When the operator decided it was necessary to remove the deposits *fast*, he called Dowell.

Dowell engineers took especially prepared solvents to the plant in truck-mounted tanks. They applied the chemicals through regular connections using Dowell-designed equipment, which includes all necessary pumps and control devices. Both the steam and water sides of the condenser were cleaned in just 13 hours.

As a result of Dowell Service, the condenser's heat-transfer efficiency was increased 25%; vacuum was boosted from 25.90 inches to 27.60 inches. The operator reported that the increased operating efficiency of the condenser paid for the chemical cleaning within 10 days.

Dowell holds dismantling of equipment to a minimum on every job. The liquid solvents used can go wherever steam or water will flow, reaching places inaccessible to other cleaning methods. Dowell's experience, especially designed equipment and job-tailored solvents are designed to restore maximum efficiency to your equipment—fast!

For full information and estimates on cleaning *your* production facilities, call the nearest Dowell office. Or write Dowell Incorporated, Dept. G-23, Tulsa 1, Oklahoma.

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

ELLIOTT STRAINERS

DESIGNED TO GET LIQUIDS... "TROUBLE-FREE" CLEAN

THERE'S NO CHANCE of foreign matter gumming-up your costly liquid-handling equipment when Elliott Strainers are on the job. They have proven an excellent method of removing objectionable solids from water, fuel and lubricating oil, gasoline, and in fact any strainable liquid. Backed by over fifty years of Elliott design and construction experience, these present-day strainers are servicing thousands of power and industrial plants everywhere. The line offers a great variety of types including Single, Twin and Self-Cleaning Strainers, covering pipe sizes with an I. D. of from 1" to 24". For detailed information on any or all of these strainers, call your local Elliott Field Engineer or write Elliott Company, Accessories Dept., Jeannette, Pa.

TYPE "V" TWIN STRAINER—Specially designed for lube oil, fuel oil and viscous liquids. Available sizes 1" to 8" for 125, and 1½" to 10" for 300 and 500 psi. Straining baskets available with 1/64" to 3/16" mesh.

TYPE "A" TWIN STRAINER—For water and other liquids . . . available sizes 4" to 24" for 125 psi—4" to 12" for 250 psi. Straining baskets available with 1/32" to ⅛" mesh. The twin strainer design, with one chamber always available for service, assures clear liquids on a continuous basis.

TYPE "K" SELF-CLEANING STRAINER—For removing large amounts of dirt and foreign matter in water only. Available sizes 4" to 24" for pressures from 25 to 125 psi. Straining units available with 1/32" to ¾" mesh. Can be furnished with AC or DC motor. The power requirement does not exceed ½ hp., in the largest size.

TYPE "F" SINGLE STRAINER—For use where the flow does not contain large quantities of foreign matter, and where the strainer can be temporarily out of service for cleaning. Available in sizes from 2" to 24". Baskets available with 1/32" to ⅛" mesh. Has a single perforated basket, convenient to handle and quickly accessible.

ELLIOTT Company AS-1

STEAM TURBINES • MOTORS • GENERATORS • REGENERATIVE HEATERS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOBLOWERS • TUBE CLEANERS • STRAINERS

More EQUIPMENT NEWS

Begins on page 156

Variable delivery gear pump

731 • Variable delivery gear pump is designed to deliver lubricant at any rate from 3½ to 10½ gph. Rate of flow can be controlled by hand while pump is in operation by use of a simple regulating screw. Positive delivery is accomplished without throttling, manufacturer states. This results in a constant and uniform delivery even when lubricant of different grades of viscosity are used.

Designed for rotary drives, the unit measures 2⅝ x 3⅛ x 3½-in. Further information on request to manufacturer.

Nathan Mfg Corp, 45-02 Ditmars Blvd, Long Island City 5, N. Y.

Ball bearing unit

716 • Two-bolt flange ball bearing unit is available in shaft sizes from ½ to 2 3/16 in. On new installations the two-bolt flange bearing eliminates two fasteners as well as punching or drilling operations for two mounting holes. In addition, according to manufacturer, it cuts installation costs and allows for closer bearing spacing on multiple shaft installations. As a replacement bearing, it fits the diagonal bolt centers on present four-bolt base flange units and carries the same load rating for a given shaft size, according to manufacturer. Request bulletin SS-125 for complete details.

Stephens-Adamson Mfg Co, Aurora, Illinois

For more data on these items, use post cards p 165. Identify your request with item number.

Electric tachometer

740 • Heavy-duty electric tachometer provides accurate, instantaneous speed indication for large industrial machinery, conveyor lines, and in other applications where maintenance-free operation under severe operating conditions is required. Completely electric, unit consists of magneto plus suitable panel indicator. Dc voltage generated by magneto is shown on indicator

Specified for More Jobs than any other small forged steel gate valve

CHAPMAN List 960

Chapman List 960 is specified for more different applications than any other small forged steel gate valve in the world. Engineers know that List 960 valves keep maintenance expenses low under the most severe service conditions.

Seizing and galling are virtually eliminated, because wedge gate faces are superhardened to 800 Brinell. Stainless steel seat rings, hardened to minimize wear, are easy to replace, make it unnecessary to lap-in gate and seats. Stem guide passages are carefully machined to minimize stresses, keep operation smooth and trouble-free over long periods. Stem-and-gate connection is extra strong where extreme stresses can develop.

For every application you have for small forged steel gate valves, specify Chapman List 960. Sizes from ¼″ to 2″. Rising stem with yoke (shown) or rising stem with inside screw. Metal-to-metal or gasketed bonnet joint, depending on application. Pressure range to 2000 pounds at 100°F, to 380 pounds at 1000°F. For higher pressures, specify List 990. Write for your copy of Catalog 10 now.

The Chapman Valve Manufacturing Co.
INDIAN ORCHARD, MASSACHUSETTS

Make Sure You Have the facts on these

SEND FOR YOUR FREE COPY OF BULLETIN 4011

Every feature of these Deming Centrifugal Pumps and the bulletin that describes them are designed to help you apply the best unit for each job requirement.

A system of unit numbers is employed in Bulletin No. 4011. Performance tables and curves for Belt driven and Motor driven units give full information and can be cross checked. Selection of the unit number from a curve guarantees non-overloading of the motor or other source of power.

The Deming Fig. 4011 Series of End Suction Centrifugal Pumps are designed to handle a wide variety of liquids. The separate liquid end construction can be furnished in special alloys for handling corrosive liquids, when specified. The support head can remain standard cast iron construction at an appreciable saving to the customer compared with an all-special alloy construction. Various optional features make it possible and economical to adapt these pumps to many applications. Sizes range from 1 to 5-inch discharge; capacities up to 1,000 g.p.m. and heads to 250 feet.

These versatile Deming Centrifugal Pumps offer you the solutions to a wide variety of liquid materials handling problems.

Send for your free copy of Bulletin 4011 NOW!

75th ANNIVERSARY DEMING PUMPS 1880 - 1955

THE DEMING COMPANY
547 BROADWAY • SALEM, OHIO

More EQUIPMENT NEWS

Begins on page 156

as any desired function of speed. Vertical or horizontal drive by worm or spur gear, pulley, chain and sprocket, or flexible coupling is readily accommodated for speeds to 30,000 rpm. Request bulletin 531, on company letterhead, for full details.

The Electric Tachometer Corp, 2220 Vine St, Philadelphia, Pa.

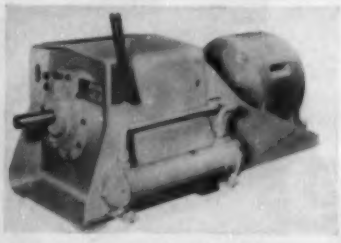
Pneumatic switches

720 • Small, simply designed pneumatic switches are suited for either surface or flush mounting. Connections are ⅛-in. NPT for supply pressures to approximately 25 psi. Positive acting diverting switches are built with 2, 3 or 4 ports. Many functions are possible with various piping arrangements. Several standard engraved dials can be furnished.

The gradual switch, above, is a precision built reducing valve. Clockwise movement of the pointer from 0 to 10 on the dial gradually increases delivery pressure 15 psi. Full details in bulletin 357.

The Power Regulator Co, Dept PRN, Skokie, Ill.

For more data on these items, use post cards p 165. Identify your request with item number.

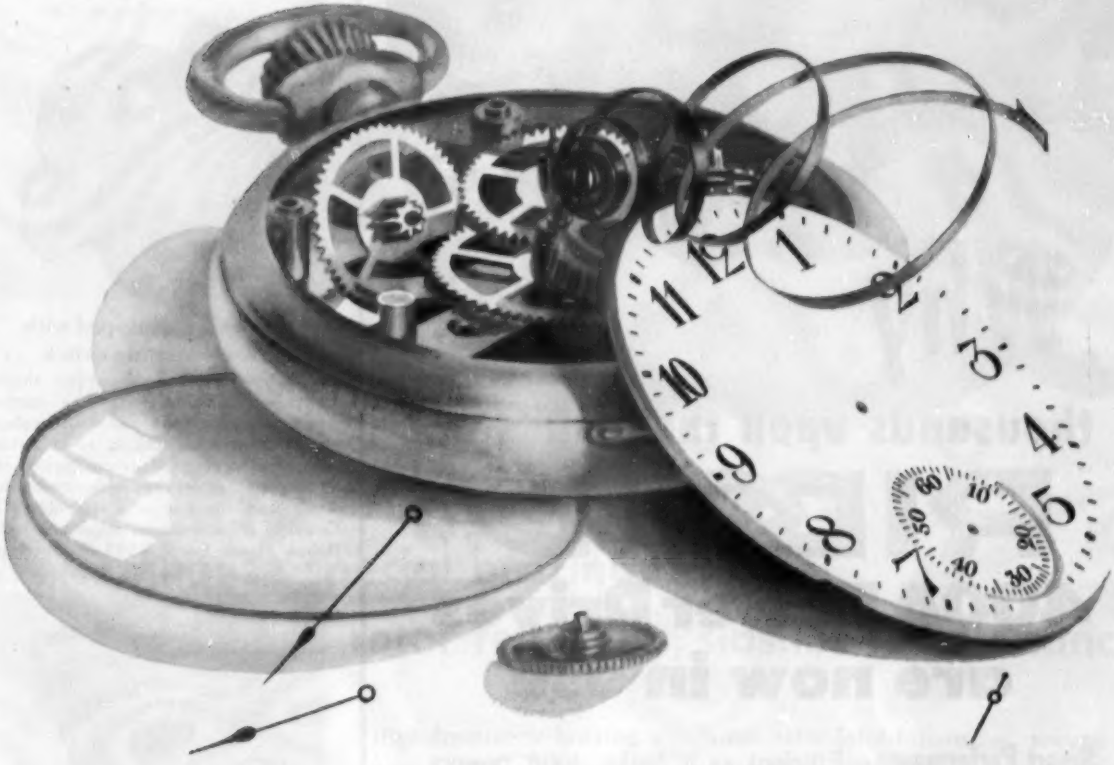


Enclosed fluid drives

738 • Completely self-contained fluid drives feature stepless speed control, no-load starting and excellent torque limiting control, according to manufacturer. The units are available for a wide range of speed adjustment on both variable and constant torque loads. They are designed for dual rotation, thus drive and load can be reversed while in motion by reversing input rotation when used with an electric motor. The drive permits the motor to come up to speed under practically no-load conditions, manufacturer states. This is said to allow simplification of motors and starting equipment for heavy starting loads.

The drive is available in six sizes from 7½ to 800 hp for operating speeds to 1800

Everything a watch should have
—except the tick!



Your plant can't "tick" properly, either—without Correct Lubrication!

Like this watch, your plant may have all the right "parts"... the finest machines made... yet may not be "ticking"—running at top efficiency—because something is lacking. That "something" is called *Correct Lubrication!*

By Correct Lubrication we mean much more than just "oil" and "grease"—which any oil supplier can provide. We mean a detailed *program* of lubrication—designed specifically for your kind of machinery and type of operation.

Working with your personnel, we analyze all your machines and their operating conditions to determine their exact lubrication requirements. Then we recommend the *right* Gargoyle product for every moving part, advise on correct methods of application, set up proper lubrication schedules, follow up regularly with progress reports on benefits achieved.

In plant after plant, such a program has effectively boosted production—materially cut maintenance costs. It can do the same for you. Why accept less?

Socony Mobil

Correct Lubrication

FIRST STEP IN CUTTING COSTS

SOCONY MOBIL OIL COMPANY, INC., and Affiliates: MAGNOLIA PETROLEUM COMPANY, GENERAL PETROLEUM CORPORATION
Formerly Socony-Vacuum Oil Company, Inc.

Why

thousands upon thousands of RIDGID 400A Power Drives are now in use

Smart Performance—Efficient as it looks, 400A powers your hand pipe cutters, reamers, threaders with new ease, saving valuable time. New type wrenchless Speed Chuck operates fast, grips pipe, conduit, rod tight both forward and reverse. Quick-action centering device on rear shaft turns with pipe. Power? Plenty for pipe to 2", even to 12" with geared tools!

Really Durable—Like all RIDGID products, 400A is famous for durability. In every way, it's a lot more for your money.

See it, try it, buy it at your Supply House!

The Ridge Tool Company • Elyria, Ohio, U.S.A.

RIDGID
Work-Saver Pipe Tools

More EQUIPMENT NEWS

Begins on page 156

rpm. The heavy, welded steel housing serves as an oil reservoir as well as an enclosure for rotors, bearings, oil circulating pump and speed regulating scoop tubes. Full details on request.

American Blower Corporation, Detroit 32, Michigan

Motors are equipped with outside starting switch

741 • Single phase integral hp electric motors are furnished with the starting switch on the outside of motor. Advantage, according to manufacturer, is to further enhance ease of maintenance. Switch can be readjusted or repaired without removing motor from the line or disassembling it. Complete information on request.

Brook Motor Corp, 3543 W Peterson Ave, Chicago 45, Illinois

Diaphragm control valve

737 • Miniaturized throttling valve provides low hysteresis and instantaneous response on service to 1000 psi at 350 F over a 3 to 15 psi control air range, manufacturer states. Unit is only 6-in. high, weighs 3¼ lbs. Direct or reverse action, top mounted positioners and handjacks are available. Descriptive bulletin on request to the manufacturer.

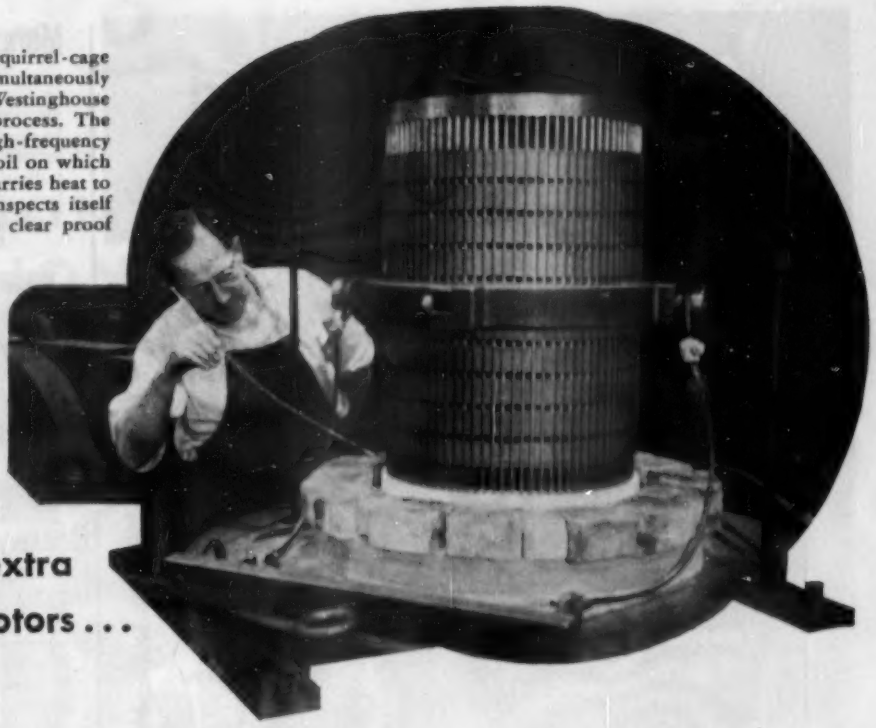
George W Dahl Company, 430 High St, Bristol, R. I.

For more data on these items, use post cards p 165. Identify your request with item number.

Safety solvent

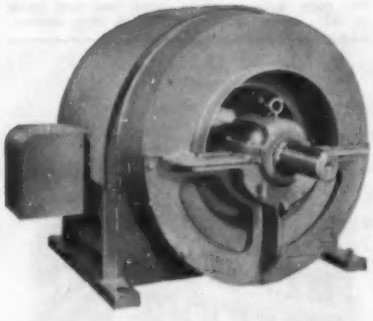
742 • Improved *Turco-Solv* safety solvent is designed primarily for cleaning electrical equipment. It is non-explosive and non-flammable (flash point over 200 F, TCC). The solvent, according to manufacturer, combines the least toxic solvents available, consistent with safety from fire hazard. Since it is non-conductive it can be used to clean hot motors in place, often without

All of the bars of this squirrel-cage rotor are being joined simultaneously to one end ring by the Westinghouse high-frequency brazing process. The end ring is heated by high-frequency currents induced by the coil on which it rests, and conduction carries heat to the bars. This process inspects itself . . . the red-hot bars are clear proof of positive joints.



A big extra in large motors . . .

Westinghouse special brazing process boosts rotor reliability, slashes maintenance



This is a large standard type CSF drip-proof motor. It can easily be modified to meet any special mechanical-drive requirement.

High-frequency brazing eliminates rotor joint failure . . . proved on over 1500 motors operating up to five years without a single failure

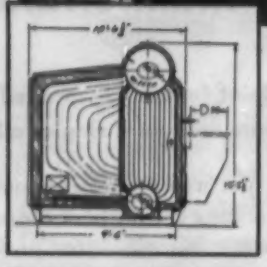
This technique licks the biggest single trouble spot in rotors of large motors. Bars are brazed to the end rings—and connections are tested at the same time. It is the only way to get solid, indestructible joints . . . your positive assurance of reliable operation under the toughest conditions.

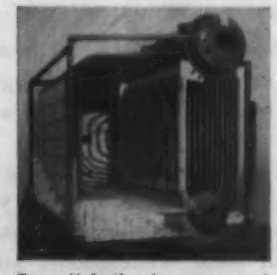
You get many important extras in Westinghouse large motors. Thermalastic® insulation, for example, gives over 20% increase in dielectric strength, 10-to-1 increase in voltage endurance—withstands moisture, dust and corrosive atmospheres.

Both of these features have been extensively proved in service. They give you a motor far superior in performance and long life . . . the closest you can come to a completely maintenance-free mechanical drive. For full range of sizes and application assistance, call your local Westinghouse sales engineer, or write: Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-10444

YOU CAN BE **SURE**... IF IT'S

Westinghouse





Type H boiler in process of shop assembly.

Here's Bigelow's new, "one-piece" answer to a wide range of steam problems. This water-tube "packaged" boiler includes burner, forced-draft fan, feed water regulator, soot blower, valves, refractory, insulation, controls and accessory equipment. It is shipped complete—ready to operate as soon as service connections are made.

Advantages

Cuts Installation Costs and Time ... Requires Small Space ... Portable ... Simple To Operate ... Fast Steaming With Safety, Efficiency and Economy ... Low Maintenance ... Handles Quick Load Changes Easily and Efficiently ... Wide Range Of Service ... Burns Oil or Gas.

Available in standard sizes for capacities ranging from 8,000 to 30,000 lbs. of steam per hr. Write for complete catalog.

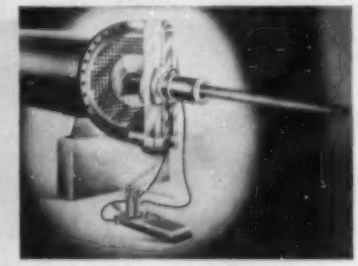
THE BIGELOW COMPANY • NEW HAVEN 3, CONN.

More EQUIPMENT NEWS

Begins on page 156

disassembly. It dries completely, without leaving residues to impair paint adhesion or to pick up carbon dust, etc. No after-neutralization is required. Descriptive pamphlet available on request.

Turco Products, Inc, 6135 S Central Ave, Los Angeles 1, Calif.



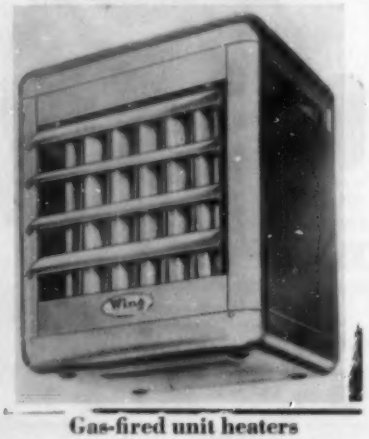
Hydraulic handling device for heat exchanger tubes

743 • Hydraulic handling device s used in removing and replacing heat exchanger bundle tubes. It can be operated by two men to push a bundle eight feet in less than 25 minutes, manufacturer states. Complete packaged unit includes pump, hose, adjustable yoke, ram, tie rods, cable and all other necessary equipment.

Adjustable yoke accommodates any heat exchanger from 8-in. I.D. Since the unit is attached directly to the exchanger shell, no temporary steel structures are required. None of the removal force is transferred to the exchanger supports. The device is capable of exerting a force of 12,000 lbs.

The M W Kellogg Company, 4 Barclay St, New York, N. Y.

For more data on these items, use post cards p 165. Identify your request with item number.



Gas-fired unit heaters

744 • Utility unit heaters with horizontal discharge are available in size range of 50,000 to 230,000 Btu/hr output. Combustion chamber and heat exchanger are built of 16-gage aluminized steel, welded into a one-piece, gas-tight assembly. Among features are built-in draft diverter, four-bladed aluminum propeller-type fans, and automatic safety controls.

L J Wing Mfg Co, Linden, N. J.

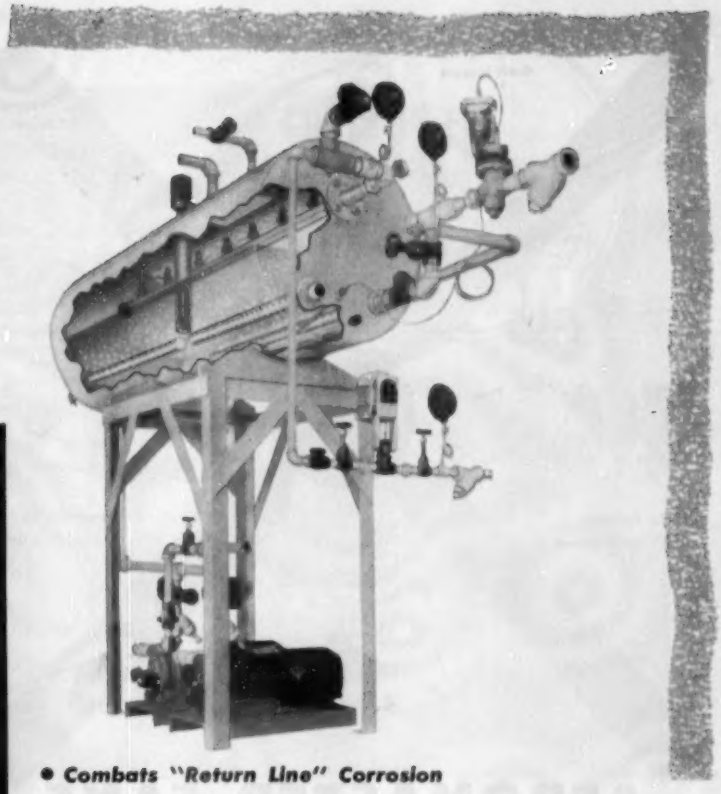
Now

"Budget-Priced" CORROSION PROTECTION

for the Small to Medium Steam Plant

The New

SCHAUB "03" Deaerator



- **Combats "Return Line" Corrosion**
- **Simpler in Principle**
- **Gives Positive Oxygen Removal to .03 CC/Liter**

It is in plants of 3,000 to 30,000 lbs/hr boiler capacity — often operating at low pressure — that "return line" corrosion is most apt to rear its ugly head. This happens even when raw water make-up is negligible.

The Schaub .03 Deaerator was designed especially for these plants. It offers an effective and economical way to "clean up" boiler feedwater that will pay for itself many times over. It is equally applicable to high pressure installations.

The *big* difference in the Schaub .03 Deaerator is that it operates fully vented at *atmospheric* pressure. Noncondensible gases escape *immediately* and *completely*. Premium cost construction is eliminated, maintenance and operating costs are reduced to a minimum. Simple but effective spray-contact vent condensing prevents wasteful steam vapor loss. Pin-point temperature control, "live action" heating, and rust proof Chromasoid lining are exclusive features.

FRED H. SCHAUB ENGINEERING COMPANY

2105 South Marshall Boulevard • Chicago 23, Illinois

Write for Bulletin 1300 — and the full story on this low-cost, more efficient Deaerator.

Simple as it is, there's a lot more to the Schaub .03 Deaerator than can be told on this page. Bulletin 1300 is filled with facts for the operating or consulting engineer responsible for boiler feedwater deaeration. It tells the "hows" and "whys", and the basic differences in the Schaub .03 method. Mail the coupon now. No obligation, of course.

NOTE: The Schaub .03 Deaerator is designed for boilers up to 1,000 HP, or 30,000 lbs. per hour. For capacities up to 100,000 lbs. per hour at .005 cc/liter "zero-oxygen" removal, write for Bulletin 575, describing the Schaub Zero-Oxygen Deaerator.

FRED H. SCHAUB ENGINEERING COMPANY
2105 South Marshall Blvd., Chicago 23, Illinois

Please send me, without cost or obligation, my personal copy of your new Bulletin 1300 on Boiler Feedwater Deaeration.

Name.....

Company.....

Address.....

City.....Zone....State.....

AEROMASTER FANS

First choice for all four

Ask the manufacturer . . . *ask the user* . . . what fan he prefers for his cooling equipment. Chances are he'll say Aeromaster.

Why? Because he knows from experience that Aeromaster Fans can be relied upon to give good service.

Aeromaster Fans are *precision-engineered,* adapted from high speed aircraft propellers. They have adjustable blade pitch and anti-flutter design . . . therefore, require less horsepower. And they last longer too, thanks to the exclusive Aeroloid blade coating to resist acids and alkalies, abrasion and weather. Overall result: Aeromaster Fans *give more cooling at lower cost.*

Available in 4, 6, or 8 blade styles, in diameters of 5 to 24 ft., with capacities up to 1,000,000 cubic feet per minute, all Aeromaster Fans are fully guaranteed.

Koppers also has trained engineering specialists available in principal cities, insuring prompt, expert Aeromaster Fan service. And Koppers is always ready to consult with you on special fan problems. Next time you plan a replacement of present fans, specify Aeromaster. When you consider new equipment, call on Koppers . . . always eager to be of service.

KOPPERS

Aeromaster Fans

METAL PRODUCTS DIV. • KOPPERS COMPANY, INC. • BALTIMORE, MD. • This Koppers Division also supplies industry with Paul's Couplings, American Hammered Industrial Piston and Sealing Rings, Koppers Electrostatic Precipitators and Gas Apparatus. Engineered Products Sold with Service

MAIL COUPON TODAY FOR COMPLETE INFORMATION

KOPPERS COMPANY, INC., *Aeromaster Fans,* 267 Scott St., Baltimore 3, Md.

Gentlemen: Please send me detailed information on Aeromaster Fans for .....(name and type of equipment to be cooled).

Name.....

Title.....Company.....

Address.....

City.....Zone.....State.....

WITH OUR READERS

Continued from page 5

As is POWER's custom, you have done a fine job in this thorough report "Today's Electric Motors." We feel this report will be of interest to many people, including those in our own organization. Congratulations on a fine piece of work.

C F MCGINNIS
Assistant Sales Manager
Elliott Company
Ridgway, Pa.

We want to make further use of this report (within our company) since we feel you have done an excellent job in the organization and presentation of the material. It is the best report of its type to be presented at this time.

H H CHAPMAN JR
Apparatus Insulation Sales
Owens-Corning Fiberglas Corp
New York, N. Y.

POWER is to be congratulated on this excellent report which deals clearly with all aspects of motors.

B P RIVETT
English Electric Export & Trading Co Ltd
New York, N. Y.

OPERATING DETAILS

Continued from page 99

If deaerator is operating under a vacuum, steam jets may remove gas. As an alternate, use one or more high-pressure steam supplies so pressure in deaerator always stays above atmospheric.

Failure to keep heater pressure up at all times is a frequent cause of poor deaerating during periods of light loads.

Besides watching vent-condenser operation, be sure heating trays are clean and properly leveled. Then incoming water is distributed evenly. It will break up into many fine streams so water heats well and dissolved gas is released rapidly. If water passes through a spray, rather than over trays, nozzles must be clean and the right size for good atomization.

Deaerator troubles. If water flow to deaerator is irregular, you may have these troubles at high flow rate: Deaerator steam pressure falls below atmospheric; drain from vent condenser floods with excessive condensation; trays become overloaded.

Best practice is to keep flow rate low enough to avoid undue steam-pressure drop. Deaerator pressure may fall at other times for instance, when turbine load is suddenly dropped and bleed-steam pressure falls rapidly while boilers call for more water because of the load drop. The steam-pressure drop causes hot water in the storage tank to flash.

Increased feed-pump suction demand also causes flashing in the suction pipe. Pump may become steambound, lose

Three 125,000 #/HR STEAM GENERATORS by Vogt AT LION OIL COMPANY'S BARTON CHEMICAL PLANT

★ The new $30 million Lion Oil Company's Barton Chemical Plant at Luling, La. produces 300 tons daily of essential nitrogen fertilizer materials to boost crop yields and reduce unit production costs on the nation's farms.

PRINCIPAL DATA, EACH UNIT

125,000 pounds per hour capacity.

Fusion welded steam and water drums designed for 725 lbs. S.W.P.

Superheater delivers steam at 750°F. total temperature.

Water cooled furnace.

Burners for Gas and Oil fuel.

Vogt offers a complete line of custom built type and package unit type steam generators. Available in bent tube types and straight tube, forged steel sectional header types for solid, liquid, or gaseous fuel burned singly or in combination. Write for bulletins.

HENRY VOGT MACHINE CO. 75th Anniversary LOUISVILLE, KY.

Henry Vogt Machine Co., Louisville, Ky.

BRANCH OFFICES:
New York, Philadelphia, Chicago, Cleveland, St. Louis, Dallas, Charleston, W. Va., San Francisco

Boiler Feed Pump Bearing
Photo courtesy Con Edison
New York

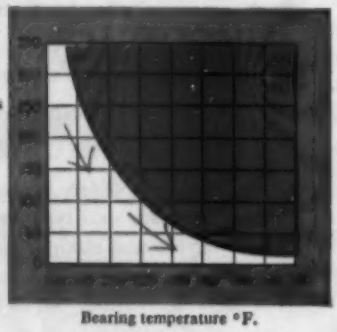
Any way you look at it, Omniguard becomes a necessity for today's high-speed automatic plant equipment. Omniguard signals *instantly* when an overheat condition is near—*before* valuable equipment or processes are harmed.

Recent studies prove, for example, that a mere 20° increase above 180°F. cuts in *half* the bearing life of rotating equipment. And this is just one instance of the devastating effects of overheat that EDISON Omniguard prevents.

Omniguard focal point is a panel easily understood at first glance—without complex gadgets—linked directly to possible trouble spots by resistance temperature detectors. Remote control indication is available too.

Omniguard's low cost is achieved 3 ways: Modular construction permits control of as few as four points or as many as are needed. Installation costs are 50 per cent less than any previous system—and maintenance is virtually nil.

You'll find it well worth your while to investigate Omniguard—a remarkable development from the world-famous EDISON *Laboratory.*



This study, published in *Electrical Manufacturing*, shows the effects of temperature vs. fatigue life of a tin-base babbitt sleeve bearing at a unit load of 2000 psi.

Thomas A Edison

A Great Name Continues Great New Achievements

Thomas A. Edison
INCORPORATED
INSTRUMENT DIVISION • 41 LAKESIDE AVENUE • WEST ORANGE, NEW JERSEY

OPERATING DETAILS

Continued from page 178

feed pressure, and be damaged. Possible remedies include (1) an emergency steam source to maintain steam pressure (2) provision for adequate suction head on pump (3) liberally sized suction lines (4) installation of an inner pipe in the storage tank to channel cooler water from vent condenser directly into the pump suction. Should other means fail, a spare pump ready for a quick start is most helpful in this situation.

Set high- and low-level alarms to warn if level in deaerator storage tanks is not safe. Hold reserve water for fast use in case of a load drop on the unit. You may also get a rapid rise in storage-tank water if (1) load increases (2) makeup-water valve operates improperly (3) broken condenser tube lets raw water enter the system. Check that you have provision for water to spill into a reserve storage tank or to waste if level approaches the bottom deaerator tray.

Boiler-feed pumps are an essential auxiliary in all steam power plants, except for very-low-pressure installations where city-water pressure is high enough to force water into the boilers. Usually, one or more pumps must be running at all times while boilers are steaming.

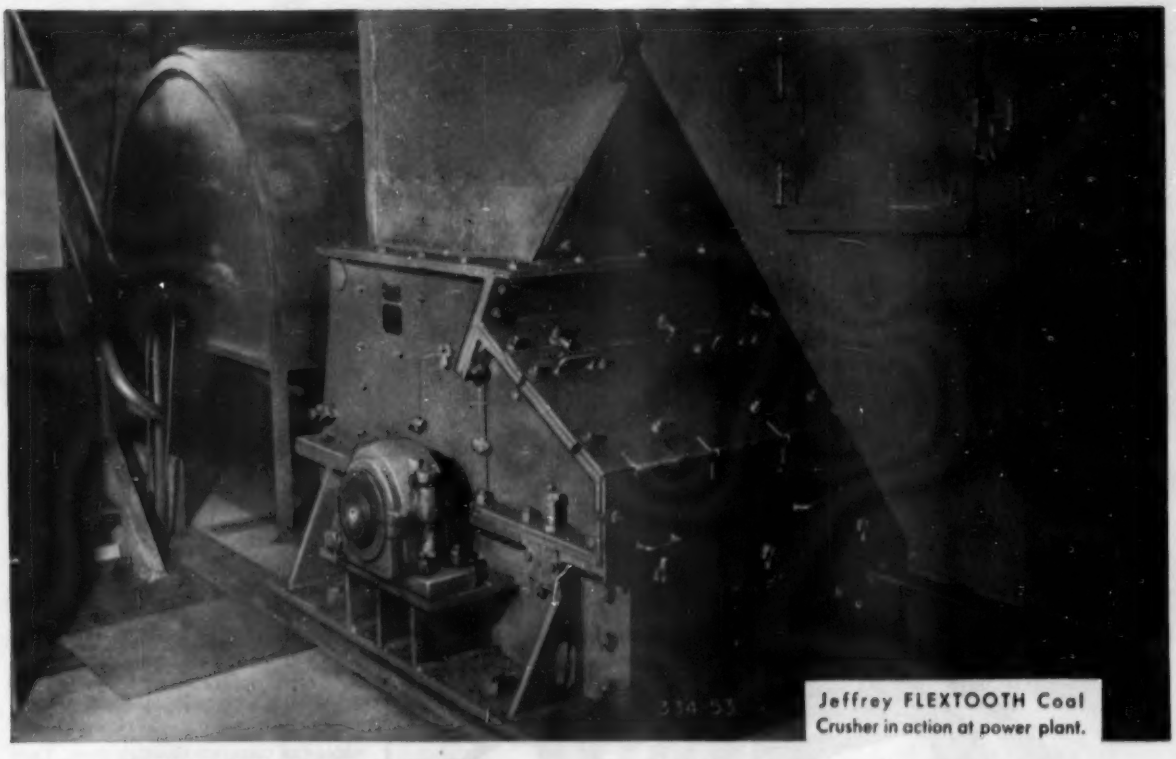
Most pumps turn at constant speed, driven by a motor or turbine. Head characteristic is drooping so delivered head falls as pump flow increases.

When friction loss in the piping, valves and economizer increases so head cannot force water into the boiler, parallel another pump with the first one. Total flow divides between the pumps so pressures are equal at the point where discharge lines meet.

Pumps must deliver the same pressure to parallel satisfactorily. In addition, head curve must be continuously drooping. If pumps have a lower discharge head at shutoff than at some point further out on their curve, load may surge severely between pumps at light loads. Use check valves at pump discharge to prevent flow reversal.

It takes considerable power to produce the high head required of most boiler feed pumps even though flow may be small. If boilers are not using water, power input will heat up the pump quite rapidly. Seizure and damage to pump parts may result. So most boiler-feed pumps have a bypass or recirculating line running to the deaerator storage tank or condenser. With flow only through the recirculating line, pump temperature rise is generally limited to not over 30 or 40 F.

Open recirculating line when first starting pump, and keep it open until

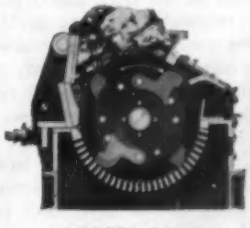


Jeffrey FLEXTOOTH Coal Crusher in action at power plant.

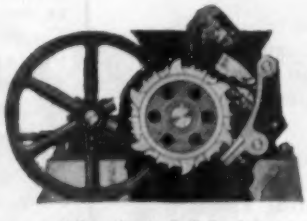
JEFFREY coal crushers insure constant supply of right sizes

Jeffrey's long experience with crushing problems assures that the coal sizing installation for *your* power plant will give greatest profit and satisfaction. Our engineers have developed a complete range of crushers that produce a constant supply of uniform sizes for top operating efficiency.

Jeffrey FLEXTOOTH and Rotary Ring Crushers were especially designed for stokers and powdered fuel plant grinders.



FLEXTOOTH Coal Crusher



Jeffrey Single Roll Crusher

CHECK THESE TEN OUTSTANDING FEATURES:

1. Reduces run-of-mine coal in one operation down to and including ¼".
2. Rugged construction with all-welded steel frame.
3. Highest grade roller type bearings.
4. Renewable steel crushing elements swing back on contact with tramp iron.
5. Heavy fly wheel pulley furnishes belt drive direct to motor.
6. Hinged breaker plate gives easy access to interior from front.
7. Built-in metal catcher may be emptied easily without stopping production.
8. Hinged doors at back have T headed bolts and latches. No bolts to lose when doors are opened.
9. Low frame requires no more head room than ordinary crusher.
10. Large screen bar area assures large capacity and uniform product.

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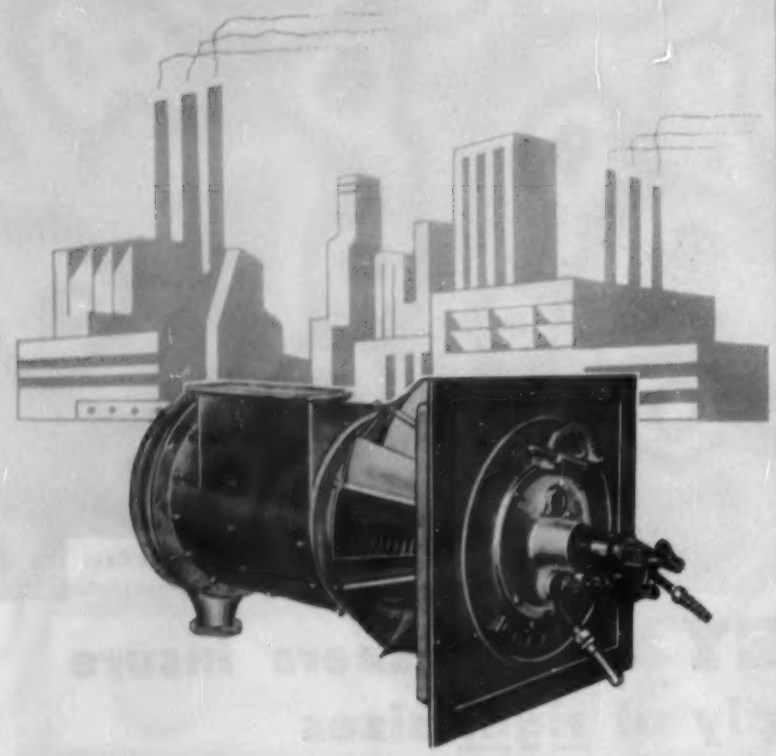

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9-169

OPERATING DETAILS

Continued from page 180

flow is up to about 25% of maximum capacity. Close off the recirculating line at high loads, since keeping it open wastes power and reduces pump's effective capacity. Frequently, automatic-control valves open the recirculating line whenever flow falls below a safe minimum. Set these controls carefully and check regularly to be sure feed pump is properly protected.

If automatic valves are not provided, you can get some protection for pumps by using a small bypass around the main feedwater-regulating valve. This should pass enough water to the boiler to protect the pump even if regulator shuts off completely. Then you have time to open pump recirculating line before water in boiler rises undesirably high. Bypass around regulating valve must be closed, of course, as soon as pump recirculating line is opened.

Boiler-feed pumps usually handle hot water. In the case of large high-pressure units, temperature strains and differential expansion may cause trouble if pump is not warmed up gradually. Most large pumps are arranged so water can circulate through them. Then they are always hot and ready to be put on the line at a moment's notice.

Keep suction valves open; discharge valves may be kept closed if an operator is stationed near the pump. If unit is started remotely, discharge valves are often left open and discharge-line check valve must prevent flow reversal in the idle pump. This practice is generally satisfactory if check valves do not slam too heavily when one pump is shut down with another still running.

Shaft packing must be carefully run in and adjusted to stand up under (1) high temperature (2) high pressure and (3) high shaft speeds. Special alloy wearing sleeves in packing glands may prevent wear on the shaft and provide an easily renewable wearing surface. The sleeves must be quite smooth and true to prevent rapid packing wear.

Check that packing is of suitable type and fits in the stuffing box properly. It should be loose to allow passage of plenty of cooling water until it wears in. Tighten gradually over several hours, or even several days, until you get a good fit.

You need some packing leakage at all times of course. Some plants arrange special condensate-recovery systems to reclaim water from this and similar sources. High-pressure glands usually have some form of labyrinth leak-off chamber that leaks off pressure to about suction-pressure level; then packing can more easily handle the rest of its job.

Cooling glands are also used to cool

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Zallea has never built one—never will. And for good reason. Like all precision engineered equipment, Zallea Expansion Joints are designed to fill specific rigid requirements. In every case, types, sizes and materials of construction are determined by factors of temperature, pressure, traverse and special service conditions.

Zallea Brothers design and build expansion joints for every requirement of modern industry. Field tests have proved the value of our emphasis on designing the expansion joint to fit the problem. Records show that Zallea Expansion Joints outlast all other packless expansion joints from 90% to as much as 1200%. Such reliability is further proof of Zallea design superiority.

Zallea representatives are always ready to help solve problems relating to expansion joints. Or if you prefer, write for Bulletin 351 which describes the many standard types available.

Zallea expansion joints

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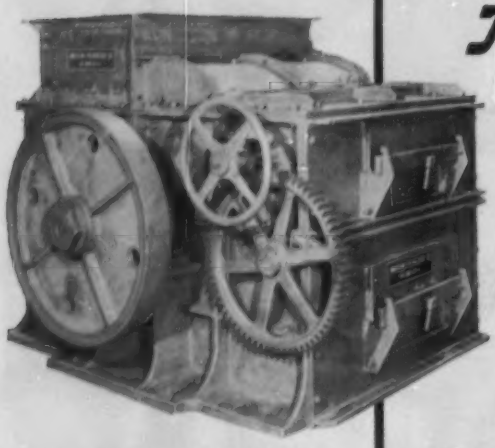
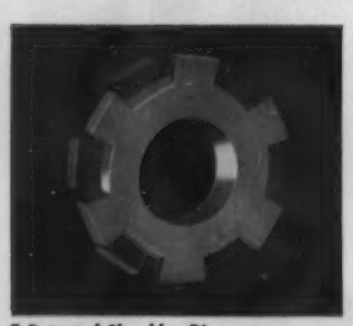
World's Largest Manufacturers of Expansion Joints

BETTER COAL CRUSHING CONTROL BECAUSE IT'S BUILT BETTER . . .

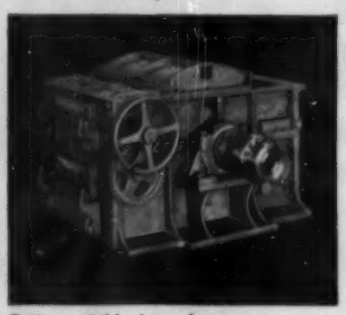


American ROLLING RING COAL CRUSHERS



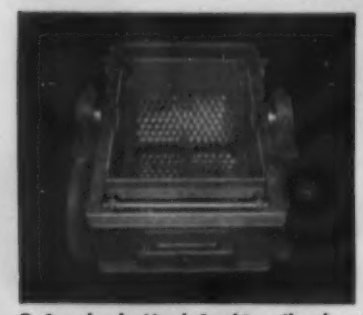
1 Patented Shredder Ring

American-originated feature that splits coal instead of smashing it—for uniform sizing, minimum fines. Result: Americans run at slow speeds, with savings in power and maintenance. No cams, shear pins, toggles.



2 Heavy-Ribbed Steel Frame

Bearing pedestals are cast integrally with lower side frames. Sectional design for easy dismantling . . . abutting joints accurately machined and bolted together for dust-tight fit.



3 Completely Lined Crushing Chamber

Heavy, renewable liners . . . sectional for easy plate-at-a-time replacement . . . engineered to offer life-time protection to the frame.

4 Complete Accessibility to Adjustment and Parts

All adjustments external—even with crusher in motion. Rotor easily reached by removing top section. Rings readily reversed or replaced. Liners quickly reached, too, for periodical inspection.

WRITE for Coal Crushing Bulletin

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OPERATING DETAILS

Continued from page 182

down the water entering the packing gland so (1) there is less packing deterioration, and (2) a type of material may be used which is less abrasive on the packing sleeve. Water passing through these cooling glands should be a type that will not cause deposits in the chamber passages.

A pump's head production quite accurately reflects its internal condition. Total head produced is the difference between suction and discharge pressure, but water temperature must be taken into account. It's most convenient to run pressure checks under some standard set of conditions that produce approximately the same feedwater temperature. You can run checks with discharge valve closed and recirculating line open, and also with pump operating close to rated capacity.

Reduction in pump head caused by internal leakage is reflected more plainly when carrying load because the drooping head-capacity curve of the usual pump accentuates the head loss at higher outputs. If pump maintains its head and runs smoothly, it is almost sure to be in satisfactory condition internally.

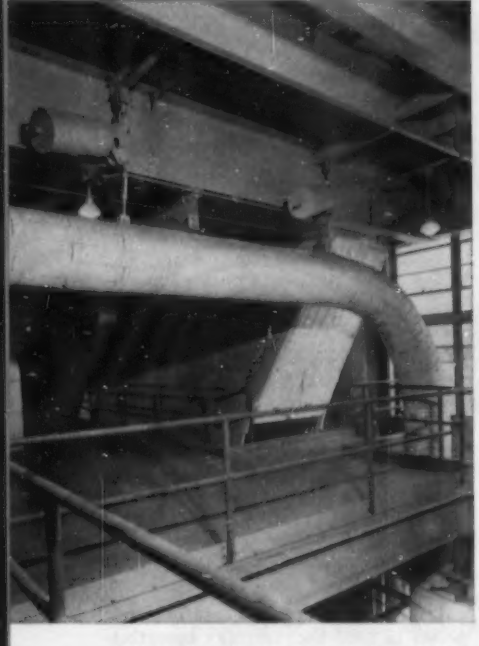
If pump has a variable-speed drive, the speed must be the same at each test or the head produced has to be corrected in relation to the square of the pump speed to get an accurate comparison.

Bearings support weight of the rotor and also resist the pump's end thrust. Thrust may be quite large if pump is not well-balanced. Various means are used to balance the thrust, such as balancing drums, and arrangement of stages so thrusts from the various stages tend to offset each other.

Some thrust bearings need an initial manual lubrication just before startup. Watch bearing temperatures closely during operation. It's also important to use proper type and weight of lubricant; bearings may be heated considerably by the hot pump casing. Large pumps often have an oil pump for circulating oil through the bearings and a cooler. Check oil levels in all bearings, and watch oil distribution between the bearings in a pump system.

When variable-speed drives are used, check the oil levels and bearings of the hydraulic or electric coupling regularly.

With a steam-turbine drive, check the turbine bearings. They may require a special lubricant to withstand the high temperatures. Be sure governor is set properly to maintain a nearly constant speed as pump load varies. Check overspeed - trip - valve setting to avoid runaway speeds in case control valves stick, pump shaft breaks, pump prime



This station, having an initial capability of 276,000 kw, was designed and erection supervised by Gilbert Associates, Inc., Reading, Pennsylvania. It is one of the most efficient and low-cost stations in the country.

At the new Shawville Station of Pennsylvania Electric Co.

it's NAVCO Piping throughout

Over 37 miles of pipe were installed by Navco in this highly efficient reheat station and all necessary prefabricated assemblies, in excess of 2,000,000 lbs., were produced in Navco shops. For field welding only, more than 15 tons of electrodes were used.

The photo above shows one of the bends required for the Main Steam. It is 16″ O.D. forged and bored with a wall thickness of 3.084″ and weighs 5½ tons. Material is ASTM A-335 P-22—2¼% Chrome. Operating conditions are 1850 psi at 1050°F. initial, with 1000°F. reheat.

The photo at the left shows this bend in service supported by dependable Navco Counterpoise Hangers.

In the past three years alone, Navco Piping has been installed in Central Stations generating in excess of 4,000,000 kw.

Next time you have a Piping job requiring reliability in performance and careful attention to every small detail, Navco will welcome the opportunity of quoting you.

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OPERATING DETAILS

Continued from page 184

is lost, etc. A small relief valve on turbine shell warns of excessive shell pressure if turbine is started with exhaust valve closed.

If steam-driven pump is used for standby only, keep it hot with exhaust valve wide open and drains on shell and on steam-supply line cracked so all parts are heated as close to normal operating temperature as possible. Watch out for possible corrosion of turbine internals if turbine is kept hot and air can enter the casing. This can occur if unit exhausts to atmosphere.

EFFICIENCY BONUS

Continued from page 109

at the same, or lower, dollars of out-of-pocket expense. If we plot either of these items on a chart, we get a bell-shaped curve for cost per M and a U-shaped curve for operating expense. Therefore, we cannot compare results with previous month in either instance, but only with same month of previous year.

As a leveling factor, let's introduce a comparison with a moving 5-year average on both figures. Such a comparison tends to minimize shock expenses, such as rebricking firebox, pointing of stack, etc. These shock expenses penalize operator in month of occurrence, but help him the following year. See October, Table VI.

Monthly total. Rather than use words to express comparisons mentioned, suppose we assign point values and determine a monthly total as in Table IV. For example, in the month of May 1954 our cost per M (Table II) was less than in May 1953 but more than 5-year average, thus earning 4 points. Operating expense (Table VI) was more than for 1953, but less than 5-year average for same month, thus earning 1 point for a total of 5 for the month. I won't attempt to say what these points are worth —that's for you to determine, as applied to your case.

But we've demonstrated the following:

1. Chief engineer would earn 74 bonus points in 1953 because: (a) operating expenses dropped $4972 below 1952 (b) in spite of increases in wages and price of fuel, expenses exceeded the 5-year average by only $968 (c) considering shock expense in October, cost per M was only 8c above 1952 and 32c over the 5-year average.

2. Chief would earn only 46 bonus points in 1954 because: (a) Operating expenses increased $2012 over 1953 and $3180 over the 5-year average. (b) Cost per M dropped 2c but only because less

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Along with the advantages of full forging properties and good design flexibility obtained with B&W Hollow Forgings, assurance of prompt delivery is important.

The B&W Hollow Forging process permits an almost unlimited mix of sizes and analyses to be produced concurrently with small loss in set-up time and tool changes. Thus, small quantities can be processed for quick delivery —even to single length orders.

Further, the wide size availability allows the designer to work closely to his optimum designs, which results in savings in both weight and cost.

The B&W Hollow Forging process provides a combination of values that users of large diameter, heavy-wall pipe and tubing would do well to consider, and avail themselves of. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.

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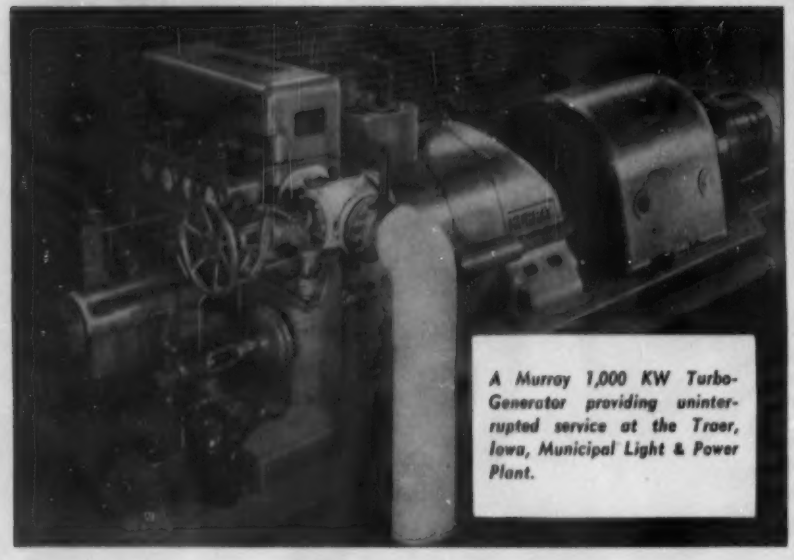
S-440

Murray Turbines



A Murray 1,000 KW Turbo-Generator providing uninterrupted service at the Traer, Iowa, Municipal Light & Power Plant.

● A typical, modern, small public utility is the Municipal Light and Power Plant at Traer, Iowa. This plant supplies water, steam heat and electric power to the community and surrounding countryside. The Murray turbo-generator pictured above carries the full electrical load of the plant and supplies the steam for heating by automatic extraction at 10# gauge pressure.

The simplified design and rugged construction of this and all MURRAY turbines particularly adapt them to this or any other drive where long life, reliability and low operating costs are a *must*.

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EFFICIENCY BONUS

Continued from page 186

steam was generated; it was still 19c above the 5-year average.

To summarize, in my opinion an incentive system is out of place in a boiler room. Due to personalities involved, above average performance is actually average. If you feel an incentive system seems justified, this article gives one way among many for you to use it.

PIPE MATERIALS

Continued from page 58

ential between inside and outside under transient conditions leads to abnormally high stresses. Ferritic alloy steels should withstand thermal stresses better than other types. But operating experience with extremely heavy wall sections is limited.

Inspection. Service-condition severity in new plants and discovery of a split steam lead several years ago focused attention on inspection of heavy wall pipe. The ultrasonic technique is growing in popularity. Though its ability to detect deep-seated defects has been demonstrated, verification by another means like radiography is customarily required.

Above 1050 F, strength and corrosion resistance are important in long-term service evaluations. The material must also be reasonably insensitive to stress concentrations, thermal shock and detrimental structural changes, and permit joining by welding.

Ferritic alloy steels are preferred for this service. Fig. 4 shows about the maximum strength obtainable with chromium-molybdenum steels.

Vanadium-bearing chromium-molybdenum steel is used in 1050-F turbine leads, is suggested for up to 1100 F. Specifications are now being prepared for a low-carbon pipe grade having 1% chromium, 1% molybdenum and 0.2% vanadium, and for two casting grades. Fig. 5 shows outstanding creep strength, due largely to the vanadium.

Scaling resistance is of greater importance above 1050 F, Fig. 6. Tests show the first 1% of chromium is quite effective in improving resistance to scaling in steam; little further gain is made until amounts above 9% are added. Low-alloy ferritic steels appear near the end of their usefulness for high-pressure high-temperature steam piping unless shorter life expectancy can be tolerated.

Austenitic steels, containing 18% chromium and 8% nickel, and sometimes modified by addition of another element, were originally utilized for their superior corrosion resistance. Structural stability left something to be

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—they looked at the record and again selected

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So to insure safe, long-lasting protection for your turbines, specify Gulfcrest—the world's finest turbine oil. Contact your nearest Gulf office today and have a Gulf Sales Engineer recommend the proper grade.

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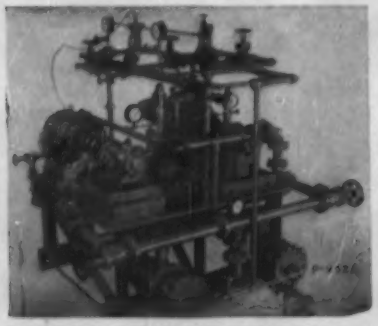

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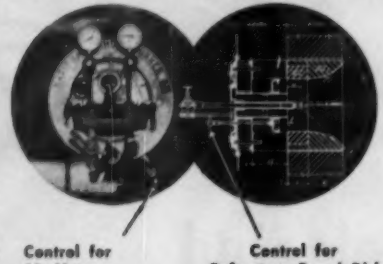

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PIPE MATERIALS

Continued from page 188

desired, and they are susceptible to development of a new phase—sigma. Latter lowers corrosion resistance and induces embrittlement.

Several years ago columbium-bearing austenitic steel, AISI Type 347, was used as heavy wall pipe and fittings for turbine leads on a number of 1050-F units. Last year an 1100-F unit was put into service with main steam piping of this material. Some 1050-F units have given trouble; others have not. Intergranular cracking, Fig. 7, is sometimes observed, usually near welds but on the parent-metal side close to the fusion line. Some cracks are also found in weld deposits and occasionally in base metal away from welds.

Cause of this cracking has not been established; more than one mechanism may be at work. Austenitic-steel weld deposits often contain microcracks, Fig. 8. Much work is in progress to improve welding electrodes to eliminate cracking tendencies.

Difficulty with Type 347 steel seems associated with its columbium content so the effect of lower columbium is being studied. Serious consideration has been given to using regular Type 304 steel for high-temperature steam piping despite its lower stress allowance. Much development work is needed before austenitic steels will give the reliable performance of the low-alloy ferritic steels.

Cast austenitic steels for valves and fittings present a further problem in structural stability. Within specification limits it is possible for the structure to be partially ferritic. For corrosive service this is not objectionable but at elevated temperatures embrittlement results from sigma-phase formation. Fig. 9 shows the change in impact resistance with time. Similar changes occur in austenitic-steel weldments containing ferrite.

With pressure and temperatures at higher levels than ever before, it seems wise to move forward with great caution. This is especially pertinent in view of the difficulties met with austenitic stainless steels, for which great hope is held in the near future. Assuming atomic power does not change present generating practice, the still higher temperatures of tomorrow's plants may be harnessed by exploiting so-called superalloys used in gas turbines, jet engines.

FEED PUMPS

Continued from page 100

pump must be large enough for the power input at H, which is larger than at L. Also, sufficient net positive suc-

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Walworth products installed aboard the *USS Forrestal* include gate, globe, and lubricated plug valves and pipe fittings. They are used on high pressure air lines, fire mains, and most of the other piping systems throughout the ship.

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Walseal is a registered trade mark which identifies valves and fittings manufactured by the Walworth Company. Walseal products have *factory-inserted rings* of silver brazing alloy in threadless ports. Walseal joints can be made only with Walseal valves and fittings.

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FEED PUMPS

Continued from page 190

tion head must be available at operating point *H*. Otherwise, cavitation may occur. If manufacturer knows the pump will run at *H*, he can choose a suitable unit.

Pump - speed changes. Throttling losses may be reduced by leaving the system-head curve as it is and changing pump speed. This is done by using (1) a steam turbine with a constant- or differential-pressure governor, or (2) a hydraulic coupling with a constant-speed motor. Both these drives reduce horsepower losses by lowering pump speed as the load decreases, narrowing the spread between the pump and system-head curves.

Turbine drive. Constant-pressure governors connect to pump discharge, are designed to allow a small unadjusted pressure rise as load decreases. This gives stable positioning of the steam inlet valves and stable turbine speed. Designated *regulation*, this pressure rise from full to zero capacity is expressed as a percent of total head.

Curve *EF*, Fig. 4, for a pump driven by a turbine with a constant-pressure governor, rises from *O* at full load to *E* at shutoff. This is a regulation of:

$(C–O)/O = (589–535)/535 = 10\%$

Operation is similar to a pump driven by a constant-speed motor with capacity varied by a regulating valve over the relatively flat characteristic curve of the pump.

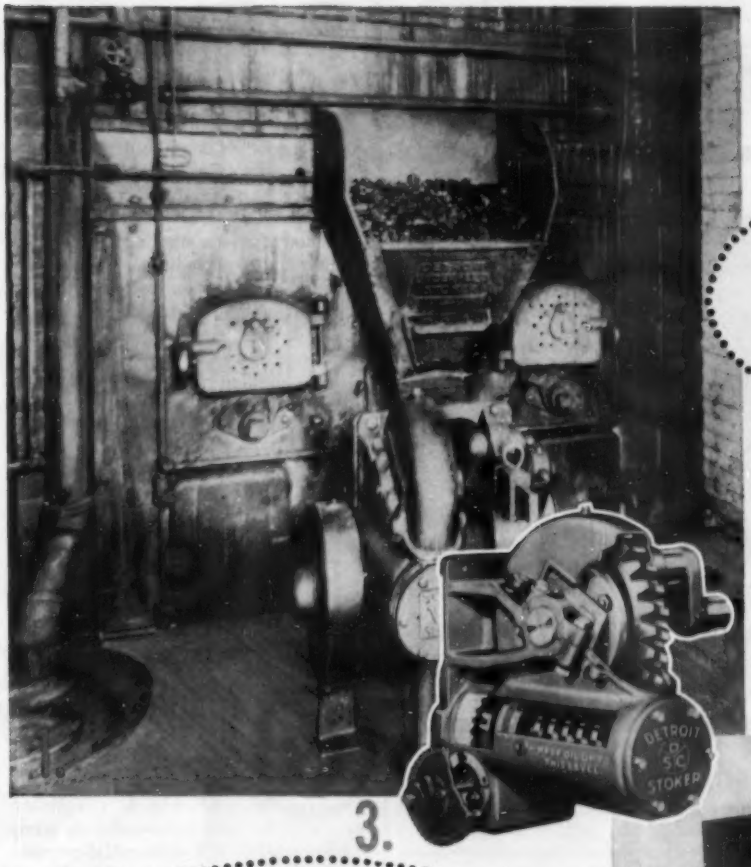
Percent pressure rise or regulation for this type of constant-pressure governor varies, but a range of 8 to 13% of total head may be considered normal. More sensitive types are available. Pneumatic or hydraulic relay-type control gives a regulation of 1 to 5%, depending on the pump discharge pressure. Such a small rise is difficult to duplicate with a motor-driven pump without danger of an unstable drooping characteristic at low capacities.

Differential-pressure governor connects to both the pump discharge and the steam-drum pressure, and it has a regulation to insure stable operation. Hence, curve *GH*, Fig. 4, rises from *O* to shutoff at *G*, and the regulation is

$(G–O)/O = (544–535)/535 = 1.7\%$

Governor connection to the steam-pressure source should be made at the boiler steam drum. Regulation of this type, compared with total head, is very small. The regulation is a designed percentage of the differential pressure. It equals difference between pump discharge pressure and boiler pressure, not full discharge pressure as in the constant-pressure governor.

Normal designed regulation for better types of self-contained differential-pressure governors is 8 to 12% of the dif-



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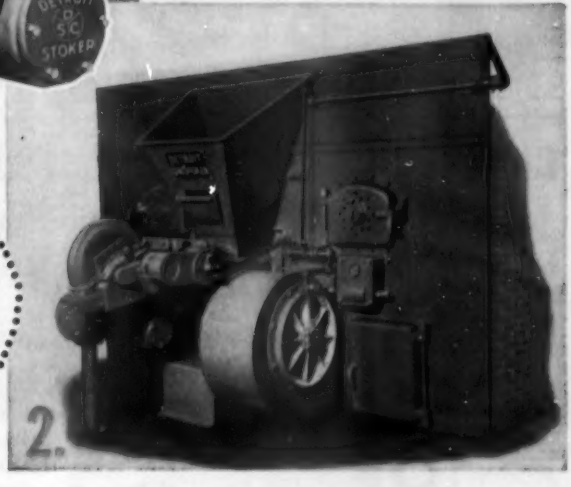

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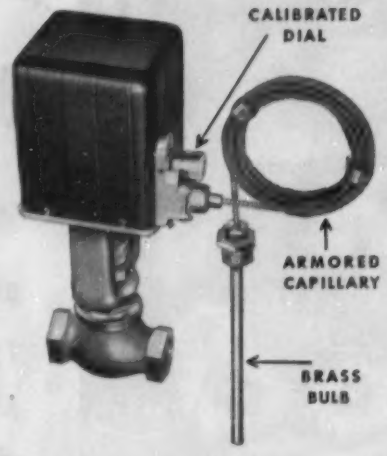

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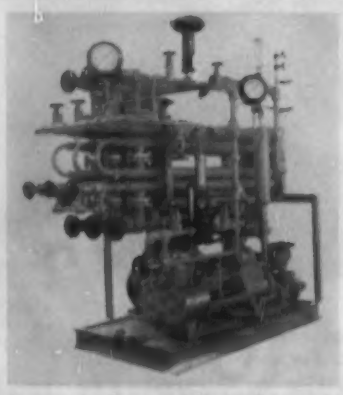

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FEED PUMPS

Continued from page 192

ferential pressure. It can be as low as a fraction of 1% of the total head. With either the pneumatic or hydraulic relay type, regulation may be decreased even further, depending on pump discharge pressure.

Motor drive. Curve *CD*, Fig. 4, shows the characteristic obtained with either synchronous- or induction-motor drive. Though an induction motor has a slight speed rise with load decrease, it is so small it can be considered negligible here.

To complete the picture of pump drives, curve *JK* is given to show the characteristic of a steam-turbine-driven pump with the turbine under the control of a constant-speed mechanical-flyball-type governor without a relay or travel amplifier. Speed regulation is 3% between zero and full capacity, giving a 3% speed rise through this range of capacity. With a special relay-type speed governor, this speed rise can be halved.

Results may be poor if the following combinations of identical pumps are run in parallel: (1) Motor-driven pump having a pressure rise appreciably different from turbine constant-pressure governor regulation at low capacities, curves *CD* and *EF*, Fig. 4. (2) Motor-driven pump and turbine-driven pump under control of a differential-pressure governor, curves *CD* and *GH*, Fig. 4, without a special valve to equalize pressures. (3) Motor-driven pump and turbine-driven pump under constant-speed governor control when operating at low capacities, curves *CD* and *JK*. (4) Motor-driven pump and turbine-driven pump with constant- or differential-pressure governor when pump suction pressure varies appreciably. The turbine changes speed to make up any variation, but the motor does not. (5) Motor-driven pump and turbine-driven pump with a differential-pressure governor where boiler steam pressure varies appreciably.

In specifying new pumps to add to existing units, it is important to have reasonable duplication of operating characteristics between motor- and turbine-driven units, as well as between each motor-driven unit. One good way of doing this is to give the manufacturer full details of existing pumps so he can choose new units correctly.

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FEED PUMPS

Continued from page 194

motors, the coupling gives automatic or manual control of pump output to follow system-head curve *AB*, Fig. 2 and 3. One method controls pump speed directly from feedwater level, with the feedwater regulator inactive. Though throttling losses are eliminated, the coupling itself has certain inherent losses. Each installation is evaluated on its own merits to see if a hydraulic coupling can be justified.

ATOMIC RADIATIONS

Continued from page 96

(10^{-24} sq cm per nucleus). A large number of structural metals have capture cross sections in the range of 0.1 to 5 barns. Here's the relation:

Thermal-neutron flux	*Time to produce 1% of solute isotope*
10^{13}	32 years
10^{14}	3.2 years
10^{15}	4 months
10^{16}	12 days

The highest thermal-neutron flux of any reactor now in existence, the Materials Testing Reactor (MTR), is about 5×10^{14} neutrons per sq cm [3]. The relation above shows that the percent of solute formed by transmutation in test samples to date is well under 1%. As reactors continue to run and are made to run at higher fluxes, the alloy problem will become of greater importance.

Atomic displacements depend on the neutron energy and the atomic weight of the material. For aluminum, minimum neutron energy needed to cause displacement is about 370 ev, and for tungsten about 2300 ev [4]. In reactors many high-energy neutrons hit atoms of the structural material. In turn, these atoms collide with neighboring atoms and have enough energy to displace them. Like an avalanche, the atoms are knocked out of position and collide with other neighboring atoms until the last to move do not have enough energy to displace still other atoms. The excess energy then dissipates as heat.

Ozeroff [5] calculates that a 2-mev neutron passing through iron displaces 25,000 atoms in slowing down to 0.02 mev. He also shows that the number of atoms displaced varies inversely with the atomic weight; more atoms will be displaced in aluminum than in tungsten. Calculations show that metal specimens in the high-flux region of the MTR may have a total number of atoms displaced every ten days equal to the total number of atoms in the specimen. Undoubtedly some atoms are displaced

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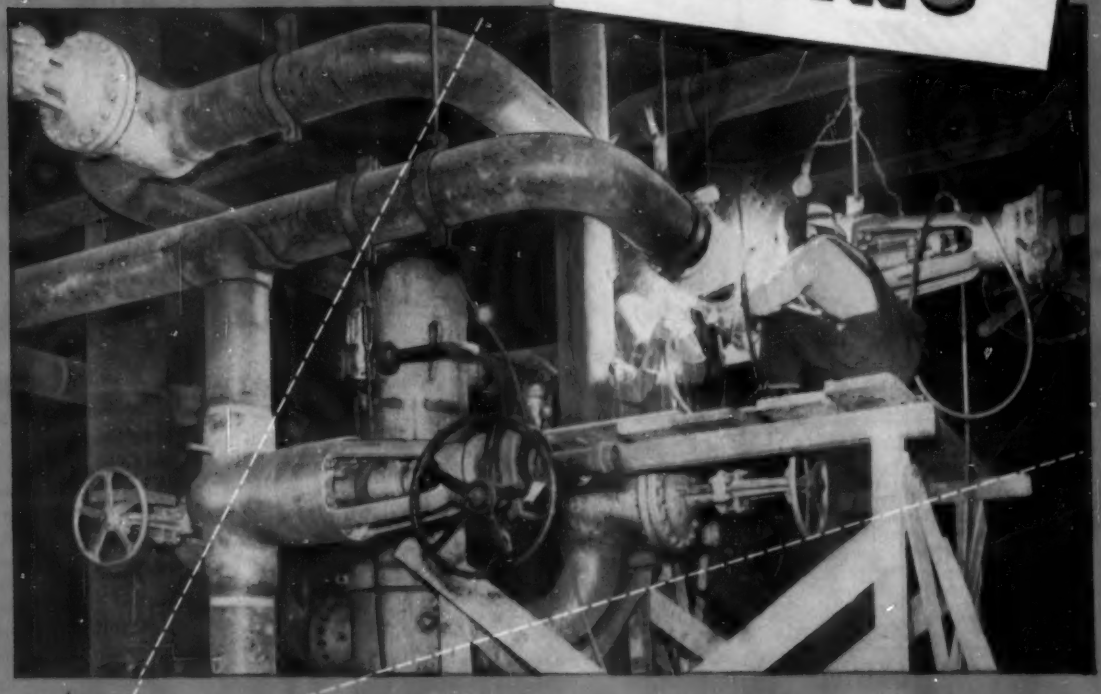

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ATOMIC RADIATIONS

Continued from page 196

many times and others not at all. With atoms being knocked about, defects appear in the metal lattice in the form of interstitial atoms and lattice vacancies. The number of defects in the metal at any time also depends on the metal temperature during exposure.

Testing. Since metal properties depend on the kind and positions of the atoms and on the phases present, we see that radiations alter such properties. Present knowledge of radiation effects is far from complete because of experimental difficulties. Instrumentation for making tests of specimens while in a nuclear pile is so complex that most testing must be done before and after specimens are placed in the radiation field.

Very often specimens must be "canned" to prevent corrosion and contamination, and provisions made to remove heat generated by gamma radiation. When specimens are removed from a reactor they usually are highly radioactive. They must be de-canned and tested with remotely operated facilities. In addition, controlling and measuring experimental variables is not easy; main factors are: exposure temperature, neutron flux and total neutron exposure.

For radiation exposures up to 5×10^{20} nvt and neutron fluxes up to 5×10^{14} nv we can make the following general conclusions:

1. There is no change in microstructure of annealed, structural metals after irradiation at temperatures below 100 C. Fig. 2 shows a series of micrographs of the same field in a molybdenum specimen before and after irradiation. A Tukon hardness indentation identifies the field studied.

2. Strength increases and ductility decreases as shown in Fig. 3. The curves are for two irradiated and two unirradiated specimens of 347 stainless steel; exposure was about 7×10^{19} nvt.

3. Rate of change in physical and mechanical properties decreases with exposure time at constant flux. Fig. 4 shows increases in hardness versus integrated neutron flux for samples of 347 stainless steel that had various amounts of cold reduction in thickness before irradiation.

4. Radiation-induced changes in properties are less for a metal in initial condition of high hardness and strength than in an annealed condition. Fig. 5 shows the radiation hardening for unworked metal is greater at each exposure than for metal cold reduced in thickness by 10%. Even though radiation hardening is less for the cold-worked material, the final hardness is

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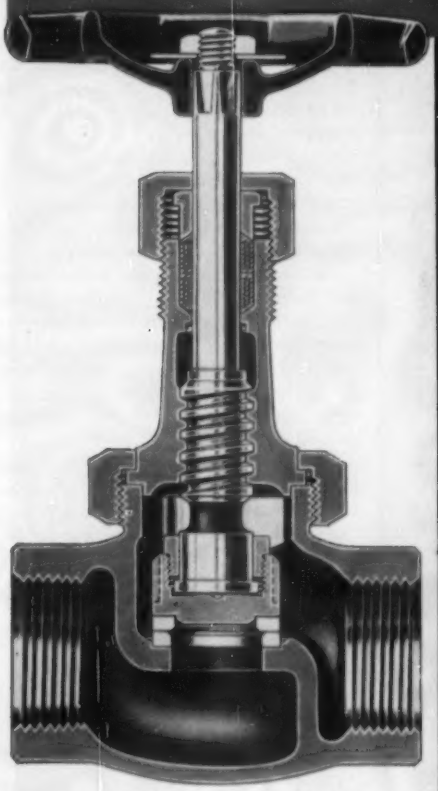

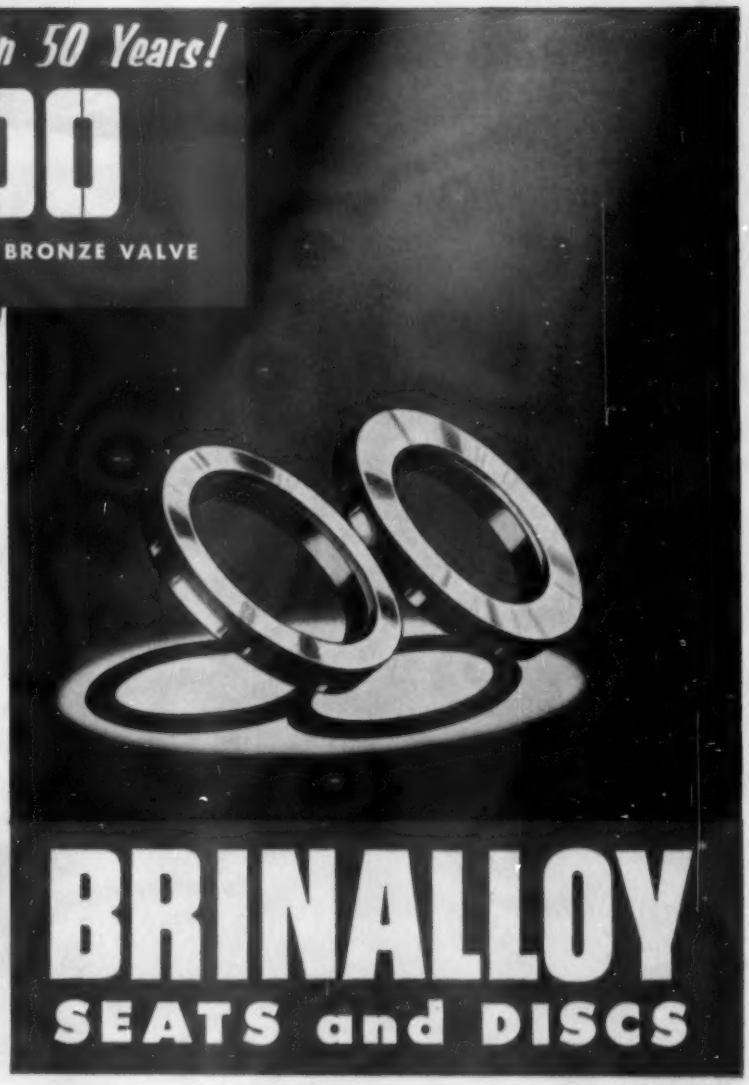

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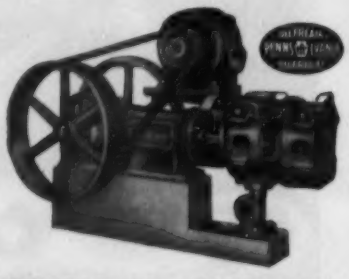

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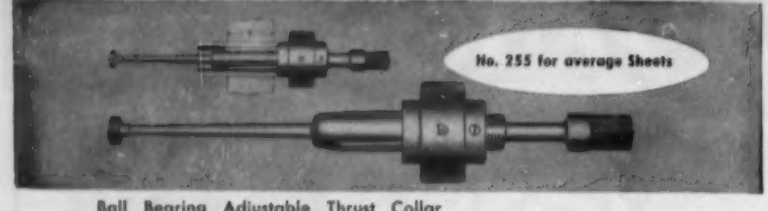

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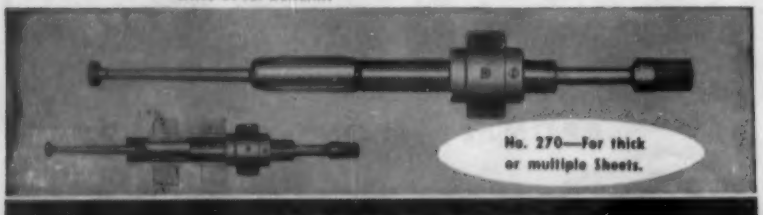

THE GUSTAV **WIEDEKE** COMPANY
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ATOMIC RADIATIONS

Continued from page 198

greater than for the unworked material.

5. Radiation-induced property changes are less in a given metal for higher exposure temperatures.

6. Radiation effects are similar in some ways to those of cold working and alloying.

7. Gross effects of radiation on metal properties are: (a) density—decreases (b) thermal conductivity—decreases (c) electrical resistivity—increases up to 25% (d) hardness—increases up to 65 Brinell hardness numbers (e) yield strength—increases up to 450% (f) ultimate strength—increases up to 75% (g) impact strength—decreases (h) transition temperature—increases (i) elastic constants (Young's modulus, Poisson's ratio)—little or no change.

Loss of ductility is the most important radiation effect. Although available data indicate that radiation effects saturate, conclusive experimental proof is still lacking. If ductility continues to decrease with higher fluxes and exposures, many metals may be seriously embrittled.

We know almost nothing about the effect of flux. We don't know if property changes will be the same for identical total exposures by long time at low flux or short time at high flux. The following list shows the relation of flux and exposure time to get an integrated exposure of 10^{21} nvt:

Neutron flux	*Exposure time*
10^{11}	317 years
10^{12}	31.7 years
10^{13}	3.17 years
10^{14}	16.5 weeks
10^{15}	11.6 days
10^{16}	1.16 days

These figures show the relative times needed to compare flux effect for constant exposures as well as time needed to exceed the limits of present knowledge for various fluxes. The designer has some quantitative data with which to work for neutron fluxes below 10^{13}, but for fluxes above 10^{14} he must extrapolate from present data. His best guide is the performance of metals now in service in reactors.

1. *Neutron Cross Sections*, AECU-2040, May 15, 1952. $1. Available from Office of Technical Services, Dept of Commerce, Washington, D. C.

2. J Stokley *Nuclides and Isotopes*, 3rd edition, 1953, Dept 2-119, General Electric Co, Schenectady 5, N. Y.

3. J R Hoffman, "The Materials Testing Reactor," *Nucleonics*, Vol 12, No. 4, April 1954, p 21.

4. F Seitz, *On the Disordering of Solids by Action of Fast Massive Par-*

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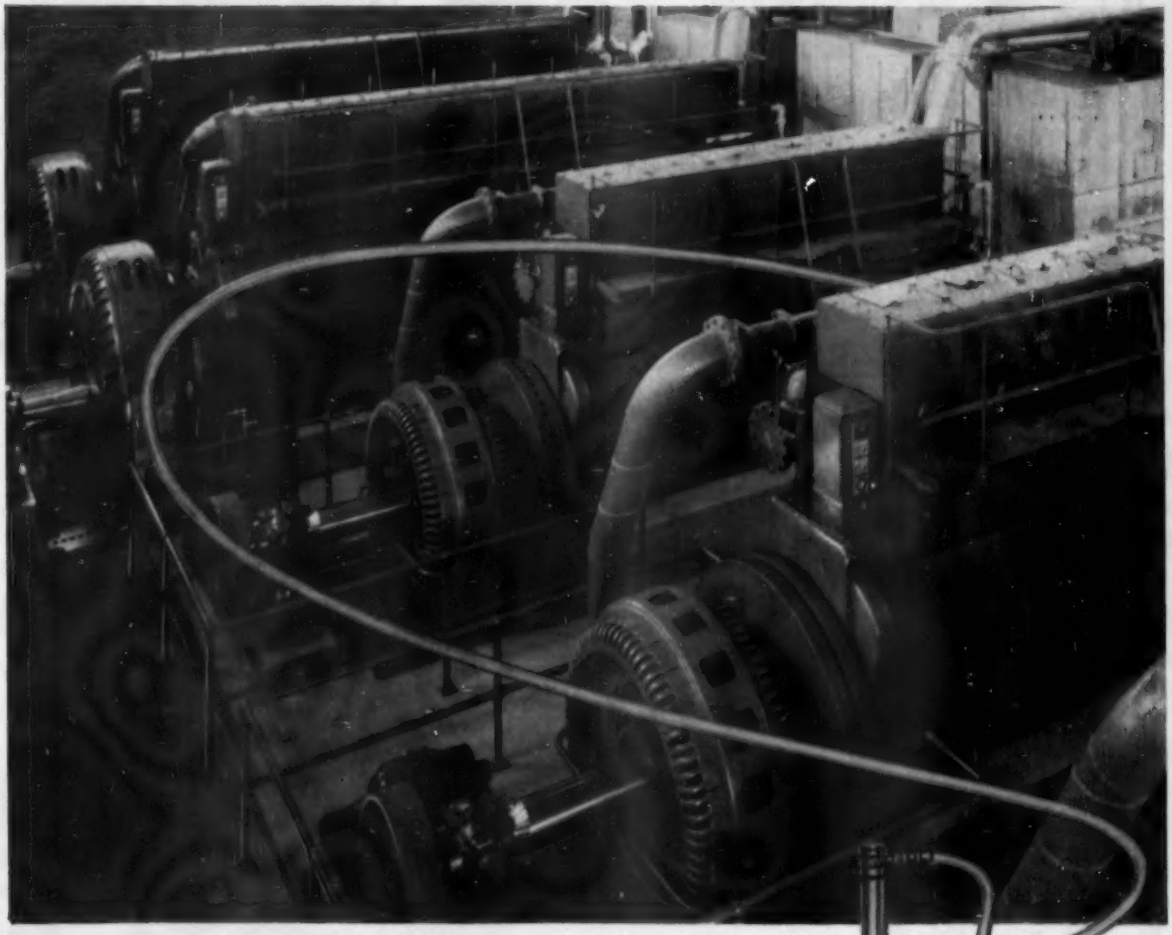

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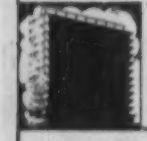

3 COOLING WATER TREATMENT AND ALGAECIDE

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ATOMIC RADIATIONS

Continued from page 200

ticles, Discussions of the Faraday Society, No. 5, p 271, 1949.

5. J Ozeroff: unpublished work on atomic displacements produced by fission fragments and fission neutrons in matter, Knolls Atomic Power Lab, 1949.

More PLANT PROBLEMS

Begins on page 132

AG should try index cards

WE FIND that the answer is a 5x8-in. index card, listing: equipment description, manufacturer, cost and service record, on front side, maintenance analysis schedule is on back. For instance, on air-conditioning equipment, back of card reads:

(17) Take fan-discharge static-pressure reading.

(18) Close bypass. Completely open maximum-outside-air damper. Close return damper.

(19) Take another static pressure reading as in (17). If this static pressure reading is lower than in (17), outside air intake is clogged.

This system takes a little more time to set up, since each step is outlined in logical order. But it makes sure that your men don't overlook important items on complex equipment. In the long run it saves time and dollars.

L W FITZPATRICK
Jefferson City, Mo.

OTHER GOOD ANSWERS

The following readers gave good advice, but we lacked the space to print their letters.

Thermal stresses:

J BRODSKY	*Newark, N. J.*
L W FITZPATRICK	*Jefferson City, Mo.*
P D HOBSON	*State College, Pa.*
C G HOWARTER	*Canton, Ill.*
W M HUFF	*Chamois, Mo.*
A M PALMER	*Brooklyn, N. Y.*
R R SCROXTON	*Akron, Ohio*
H B WAYNE	*Brooklyn, N. Y.*

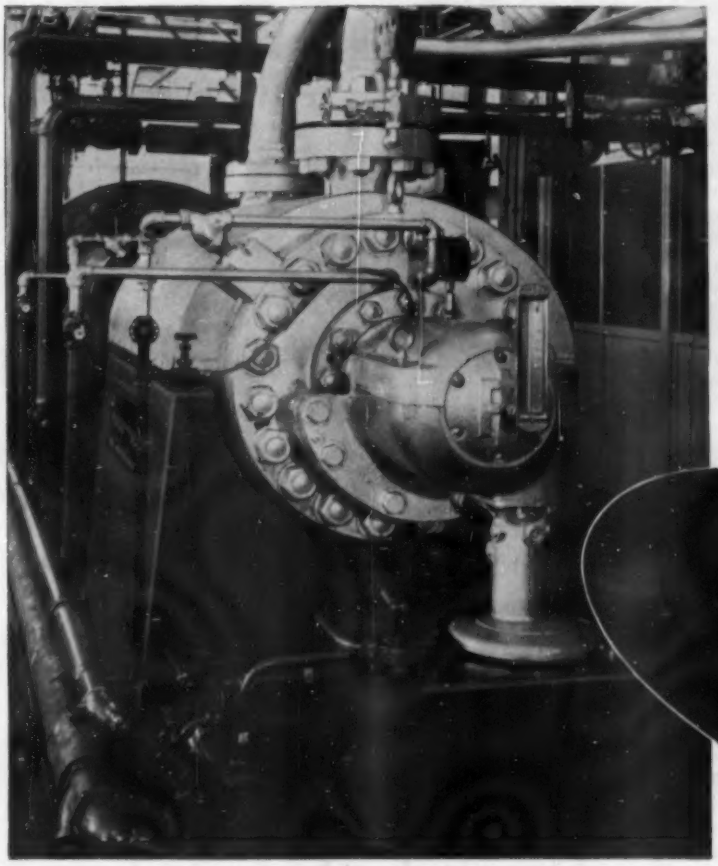
Maintenance sheets:

C G HOWARTER	*Canton, Ill.*
P D HOBSON	*State College, Pa.*
W M HUFF	*Chamois, Mo.*
J W SMITHWICK	*Henderson, N. C.*
H B WAYNE	*Brooklyn, N. Y.*

When POWER arrives at our plant, we all have one question in mind. "What's old Marmaduke Surfaceblow blowing off about this month?" And he is the first thing we always read.

M HEGE *Clinton, Iowa*

I-R PUMP MAKES NEW RECORDS for RCA VICTOR



PUMPING music into a phonograph record is a somewhat unusual assignment for an I-R pump. Yet that's exactly what this high-pressure CHTA unit is required to do. For it supplies power to RCA Victor's huge hydraulic record presses, where metal stampers mould the recorded grooves of music into the Vinylite surface of the disc at a pressure of about 1800 psi. That's almost 150 tons for a 7″ record!

The Ingersoll-Rand CHTA pump shown above is provided with a fluid drive coupling which permits discharge pressure to be maintained within 25 pounds of the 1800 pound design pressure, regardless of flow. This uniform pressure helps RCA Victor records achieve consistently faithful reproduction of the original live sound.

I-R maintenance-free DMV single-stage pumps return the spent water from a reservoir to the high pressure pump suction at 40 psi. Careful instrumentation by RCA engineers guards the entire system and provides warning of any unusual operating conditions.

Other I-R equipment at this same RCA plant includes service water pumps, and non-lubricated compressors that supply oil-free air used in TV tube production.

Ingersoll-Rand pumps are known throughout industry for their quality workmanship and dependable performance. Consult one of our branch offices on your pumping problem—there's an economical solution in the complete I-R pump line, no matter what the requirements.

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MARMADUKE

Continued from page 144

ated out in the wheat fields in Montana years before.

"Firing was from the big hog-fuel pile near the saw. A large wooden barrel near the boiler stored the feedwater. This barrel had a hose leading to the creek and the barrel was filled with a steam injector. Same injector was used for feeding the boiler from the barrel, after opening and closing a few bypass valves. When the boiler's water level reached the bottom gage-glass nut, the fireman injected water until the level reached the top nut. Those boilers were tough or they couldn't have stood all that cold, dirty makeup water being shot into them every few minutes.

"After Epps and I shook hands, he introduced me to the young inspector who was giving the boiler the annual hydrostatic test. From what I could learn, Epps had cleaned the boiler the day before, filled her with water right up to the air cock atop the steam dome. All the inspector had to do was attach his test gage to her drum, hook his small hand-type hydrostatic test pump to her feed line and bring up the pressure. She normally steamed at 150 psi, so he was trying to raise her to one and a half times that, or 225 psi.

"But trouble was that his little hand pump couldn't get her past 219 psi. The inspector had his sleeves rolled up and the hot July sun was making him sweat as he pumped away. It was plain to all of us that the water leaked past the pump's piston at that high pressure and she wouldn't force any into the boiler.

"I watched while a husky lumberjack took over and gave that pump merry hell. The inspector and Epps glued their sights on the test gage. But she just wouldn't go higher than 219 psi. 'She's still six pounds short,' said the inspector with a worried look, tapping his gage lightly. 'And she looks like she'll stay there.'

"'That's close enough,' growled Epps, getting his voltage up. 'If this kettle doesn't pop her rivets now, she never will.'

"'That's not close enough for *me*,' said the young inspector. 'Your state's law says one and a half times working pressure and that's exactly what I'm going to bring her up to or you won't get a certificate of inspection.'

"Epps blew his stack. 'Look here inspector,' he yelled, 'I've already lost a half day's work waiting for you to test this boiler. It isn't my fault that your godam pump doesn't work. Now if you don't want to pass her, the hell with your company. I'll just fire her up and that's that.'

"'Hold everything, boys,' I barged in. 'I'll have this boiler up to 225 psi

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MARMADUKE

Continued from page 204

and you can start steaming her up right after lunch. But first let's drive down the road to that roadhouse I passed coming up here and take on fuel. I'm starved.'

"The inspector was suspicious, but Epps said 'If my old shipmate Marmy here says he can get her up that's good enough for me. I don't know how he's going to do it but I know he *will*. Let's go.' We all piled into the inspector's car and shoved off.

"We got back at 1 pm. I was smoking a cigar and feeling fine. After sailing the Atlantic all winter this life of nursing a little kettle in the woods looked good to me. Epps was puffing away on his corncob pipe and even the inspector had relaxed.

"When we got out of the car the lumberjacks came over from under a tree where they had been eating lunch. 'Now I want to see how Mr Surfaceblow here is going to do this miracle,' said the inspector suspiciously.

" 'So do I,' chimed in a lumberjack.

"I walked slowly over to the boiler and looked at the test gage. 'OK,' I said to Epps. 'Far as I'm concerned, you can lower your water level and start firing her up!' Everyone crowded around me and looked at the gage. Her needle was a half pound over 225 psi.

" 'Well I'll be a son-of-a-gun,' yelled Epps, scratching his head, 'How in hell did you do that, Marmy?'

" 'Simple,' I answered, 'that hot sun shining down on this unlagged boiler expanded her water just as I expected it to do. Only reason I suggested going to take on fuel was to give the sun time.'

"Soon the inspector was giving her riveted joints the hammer test. That boiler passed with flying colors. I always did say it's no use working up a sweat when some natural law is ready to get in there and do the sweating for you," wound up Marmy, getting back to his work.

—*SME*

MARMY'S MAILBOX

Our Fellowship Committee chairman here at the St. Louis, Mo. NAPE reads all the Marmy stories. Says he is considering ordering the collection of Marmy stories in book form to be given away as prizes at our monthly get-togethers.

FRANK J VELTEN *St. Louis, Mo.*

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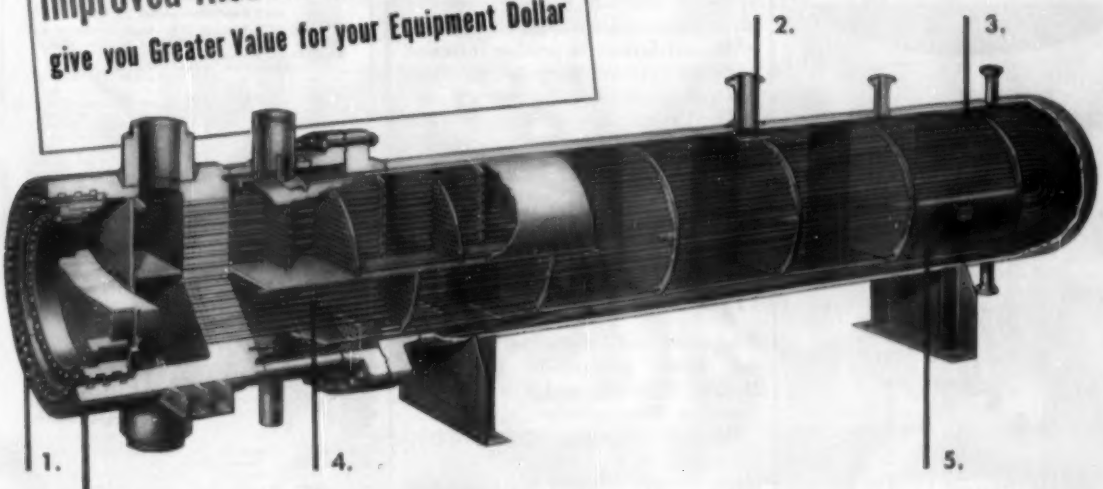

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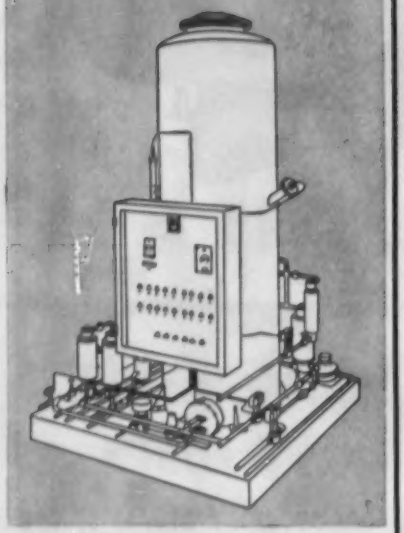

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More TECHNICAL BRIEFS

Begins on page 152

more frequent load cycling. Present operating methods must be reviewed, giving careful consideration to these additional factors to provide increased assurance of continuous service, long life and minimum maintenance.

The paper describes a practical method of operating hydrogen-cooled turbine generators to satisfy present-day operating requirements. It describes typical ventilating systems for these units. *AIEE paper no. 55-116.*

Hydro

Production and installation of vertical waterwheel generators. *By W D Houser, W Hindle and J A Tyerman, Canadian Westinghouse Co, Ltd.*

Demand for power in all parts of Canada has doubled each decade since 1910. Hydro-electric stations have handled most of the increased load. Total installed hydro capacity in Canada on Sept 1, 1954, was 16 million hp. Characteristics of the equipment installed depended, of course, on local conditions, which were never exactly the same in any two places.

This paper deals with details of production and erection found suitable in installing more than half the waterwheel generators in Canada. Construction of Kingsbury-type bearings is discussed at length.

Shop work is planned so each component is at the site when needed to meet the construction schedule. First to go are foundation bolts and details. These are followed by the frame and soleplates, spider and other rotor parts, shaft and thrust bearing, upper and lower brackets, and finally the exciters and air casing.

Former practice located soleplates individually. Now much time is saved by bolting soleplates to the generator frame and allowing it to position them for location and elevation. No paint is applied to surfaces contacting the concrete because bare metal has better adherence. *AIEE paper no. 55-162.*

Development of small hydroelectric sites in western North Carolina. *By H H Gnuse, Jr, Nantahala Power and Light Co.*

It has been economically possible to develop several small hydroelectric sites in western North Carolina during the last five years by incorporating in the structures only those mechanical, structural and electrical components actually required to produce electricity safely

Directions for ordering papers on p 210

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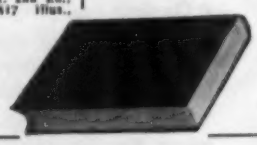
BOILER OPERATOR'S GUIDE

A dependable handbook on steam boilers, covering boiler characteristics, installation, and operating problems and solutions. Gives firemen, engineers, and inspectors detailed information on boilers of all types, auxiliaries, appliances, and complete steam plant installations. Offers valuable reference data and typical questions and answers for license examinations, plus material on plant management, inspection, and maintenance. By Harry M. Spring, Consulting Engr. 353 pp., 241 illus., $5.75



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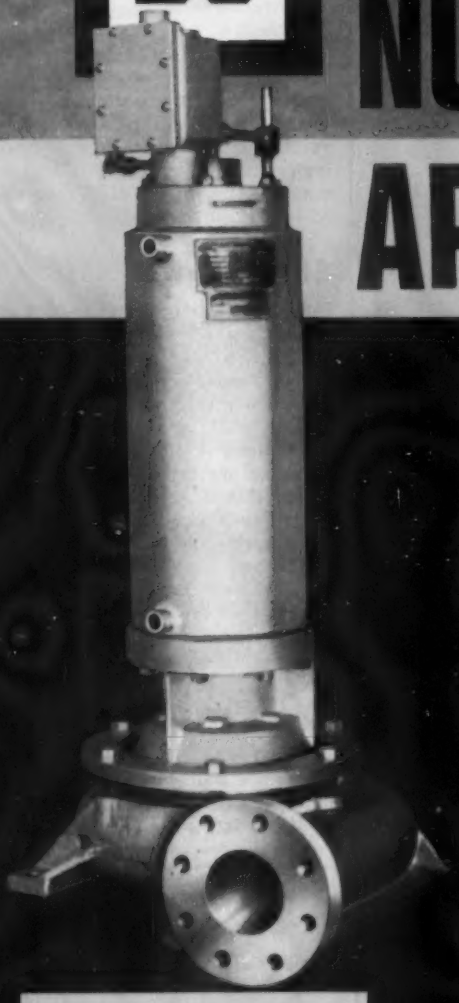
PUMPS FOR NUCLEAR APPLICATIONS



FIVE BASIC APPROACHES to nuclear fluid handling have been developed. Four are "zero leakage" types: (1) the canned motor pump; (2) the submersible motor pump; (3) the gas filled motor pump; and (4) the oil filled motor pump. These four types employ special electric drive motors close-coupled to the pump with the entire unit hermetically-sealed. The fifth approach, a "controlled leakage" type, uses a mechanical seal to confine leakage along a shaft driven by standard electric, gasoline or diesel motor or steam turbine.

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More TECHNICAL BRIEFS

Begins on page 152

and reliably with a minimum of operating and maintenance expense.

Use of the rock-fill earth-faced type construction for dams has been a major factor in providing a low-cost design. Also, use of supervisory control and telemetering to permit operation of the new plants by personnel located at existing plants has greatly reduced operating costs, thereby contributing to the economical development. Use of protective coatings of stainless steel on vulnerable turbine parts has been a major factor in reducing long-term maintenance costs. *AIEE paper no. 55-165.*

Steam power

Land based operation of marine boilers. *By E T Eyring and J O Rich, Salt River Power District, Phoenix, Arizona.*

Three marine-type boilers were placed in service at the Cross Cut Steam Plant in July, 1947, as a permanent part of the station's steam-generating capacity. Abnormal increases in system load required that these boilers be operated beyond their rated capacity until late 1953, when additional generating facilities became available.

The performance record of these boilers has been excellent, and only minor maintenance has been required. Availability has been close to 100% at all times, except when residual fuel oil was burned. The authors of this paper feel that operation of these marine boilers has been as satisfactory and reliable as any of the stationary steam-generating units presently operated by the District. *ASME paper no. 54-A-218.*

TO OBTAIN COMPLETE TEXT

Material for these abstracts comes from the following sources unless otherwise stated. Order complete paper from source, not POWER.

American Power Conference, 17th annual meeting. Identified by initials APC and obtainable through purchase from R A Budenholzer, chairman, Illinois Institute of Technology.

American Institute of Electrical Engineers. Identified by initials AIEE and obtainable through AIEE, 33 W 39th St, New York 18, New York.

American Society of Mechanical Engineers. Identified by initials ASME and obtainable through ASME, 29 W 39th St, New York 18, New York.

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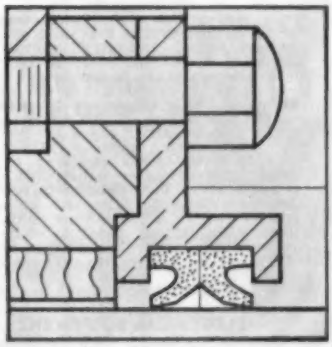
The 45,000 ton tanker, "World Glory," built at Bethlehem Steel's Quincy yard, is the largest ever built in the Western Hemisphere. The rudder stock bearings, upper and lower pintle, are protected by Split-KLOZURE Oil Seals.



Cross section shows the dual opposed Split-KLOZURE assembly on the rudder post of the "World Glory." This dependable, easy-to-install seal keeps vital lubricants *inside* the rudder trunk's voids, keeps seawater *out*.

*KLOZURE is a registered trademark for Garlock oil and grease seals.

The construction of the Garlock Split-KLOZURE* permits easy and quick application in inaccessible locations. Instead of applying over the end of the shaft or journal—as is necessary with solid, one-piece seals—the Split-KLOZURE is placed *around* the shaft or journal. This can be done at any convenient place near the bore or housing into which the seal is to be applied.

Thus, the installation of a Split-KLOZURE is accomplished with *minimum* down-time, and *without* dismantling machines *or* removing heavy shafts, bearings, gears, couplings or other machine parts. Split-KLOZURES are ideally suited for use on machines operated in localities remote from repair or service facilities.

For complete details on Garlock Split-KLOZURES, write today for bulletin AD-124.

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Conseco and its subsidiaries design, build, and install power and processing equipment and accessories, some of which are listed here. Purchasers of Conseco equipment benefit from our maintenance division's quarter century experience in rebuilding, modernizing, and maintaining our own as well as competitors' equipment. This coordination assures easy accessibility for maintenance and low operating cost. Send for bulletins covering equipment in which you are interested.

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STEAM GENERATORS
PRESSURE VESSELS
CENTRIFUGES
FILTERS and STRAINERS
PUMPS, INSTRUMENTS, SPECIALTIES

More FREE BULLETINS

Begins on page 165

14 **Refuse fuel burning equipment** is subject of illustrated 8-p bulletin. Contains data on pneumatic refuse fuel distributors, feeders, proportioners, and selection info for pneumatic spreader stoker grates. Riley Stoker Corp, Worcester, Mass.

COMPRESSORS AND ACCESSORIES

15 **Air-cooled compressor** is equipped with company's channel valve. The 20-hp unit may be direct-connected or belt-driven. Four-page bulletin includes cutaway views, specs, engr data. Form 1540. Ingersoll-Rand Co, 11 Broadway, New York 4, N. Y.

16 **Air and gas compressors,** dry vacuum pumps, check valves, aftercoolers and centrifugal pumps for handling water and aqueous solutions including boiler feeding. Illustrated 6-p bulletin 603. Pennsylvania Pump & Compressor Co, Easton, Pa.

17 **Centrifugal compressor** for natural gas transmission is driven by gas turbine, internal combustion engine, electric motor or steam turbine. Two-page diagram illustrates design features. Four-page bulletin C-1100-B57. Worthington Corp, Harrison, N. J.

18 **Compressed air handbook.** Contains hook-up sketches to help users of compressed air to improve capacity of their installations. Features cooling controls, aftercoolers and intercoolers. Bulletin 520A. Sarco Co, Inc, Dept P, Empire State Bldg, New York 1, N. Y.

19 **Aftercoolers** and separators for compressed air systems. Illustrated 12-p bulletin 711 contains cutaway views, capacity charts, tips on increasing efficiency. R P Adams Co, Inc, 225 E Park Dr, Buffalo 17, N. Y.

20 **Cooling control** holds temperature of cooling water in jackets or coils of equipment such as compressors, oil coolers, condensers and stills. Adjustment range between 40 and 200 F. Supplement 1 to bulletin 700-A. Sarco Co, Inc, Dept P, Empire State Bldg, New York 1, N. Y.

ELECTRIC CONTROLS

21 **Circuit breakers.** Fully illustrated 60-p catalog presents complete info on selection and use of molded case and large air circuit breakers. Charts and tables explain proper selection of units for motor circuits, bus duct, conductors and transformer secondary applications. I-T-E Circuit Breaker Co, Small Air Circuit Breaker div, 1924 Hamilton St, Philadelphia 30, Pennsylvania.

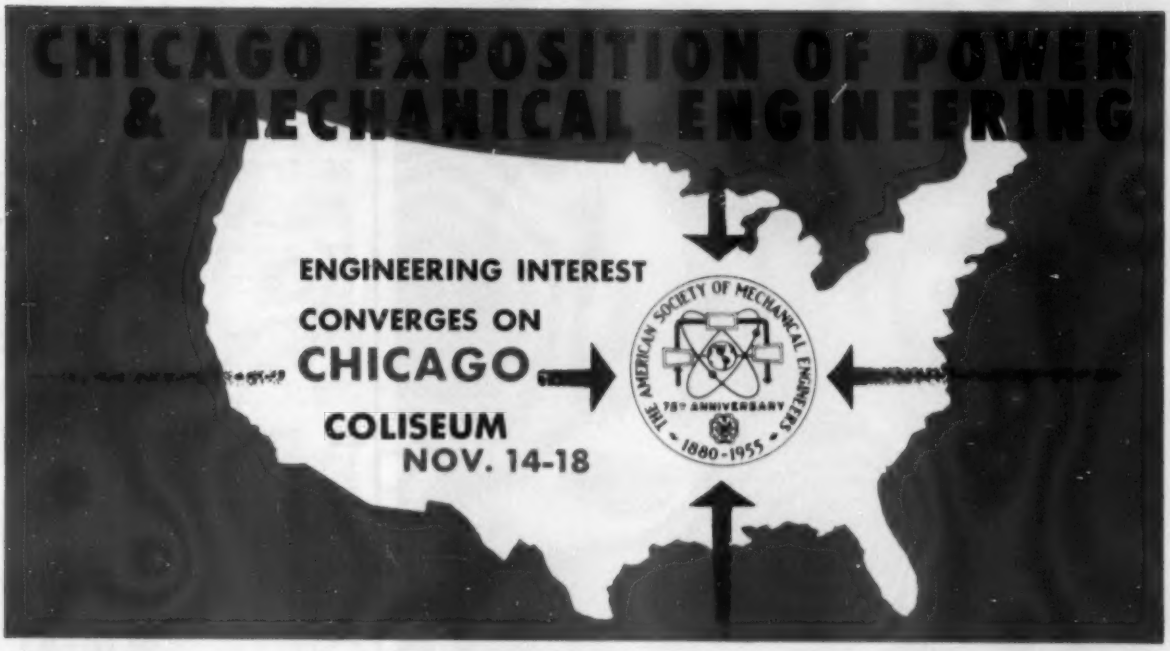
22 **Heavy duty dc contactors** and control relays for steel mill and similar heavy industry applications. Available in ratings of 25 to 100 amps, 600 volts maximum, in single and double pole units. Illustrated 8-page bulletin 14B8171A. Allis-Chalmers Manufacturing Co, 952 S 70th St, Milwaukee, Wis.

23 **Automatic controls.** Illustrated 16-p bulletin discusses conventional millivoltmeter construction and its application to a control instrument. Also describes function of an oscillator circuit in a pyrometer controller, along with various control forms that can be developed from this type circuit. Educational bulletin 9. Wheelco Instruments div, Barber-Colman Co, Rockford, Ill.

ELECTRICAL EQUIPMENT

24 **Distribution transformers.** Single-phase, oil-filled units are described in 12-p bulletin S-401-B. Contains shipping weights and dimensions, connection diagrams and NEMA ratings. Standard Tranformer Co, Warren, Ohio.

25 **Current transformer,** donut-type, for metering applications. Ranges extend from 50/5 to 3000/5 in ring type and 50/5 to 4500/5 in rectangular type. Specs, dimensions, accuracies in illus-



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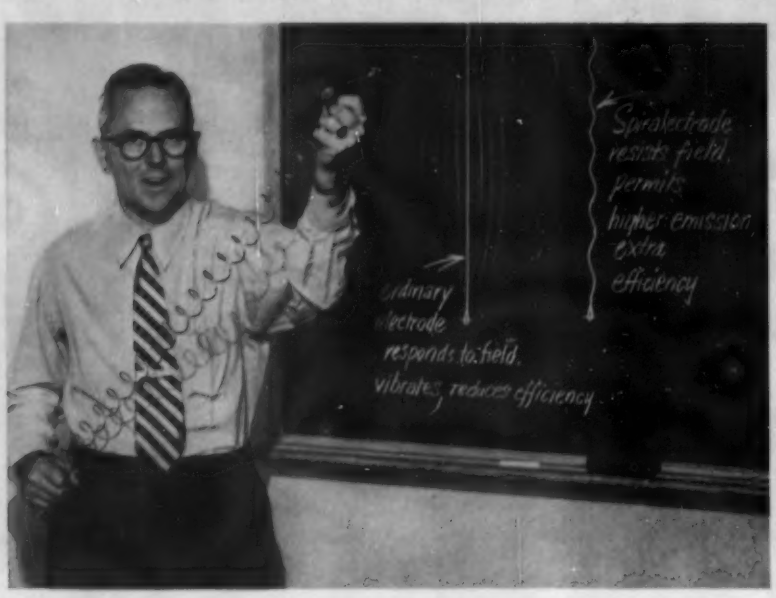
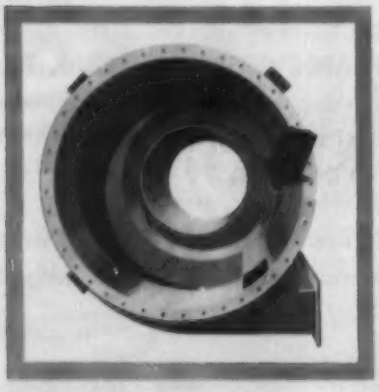
EXTRA DUST COLLECTION EFFICIENCY!


Spiralectrode resists field, permits higher emission, extra efficiency
Ordinary electrode responds to field, vibrates, reduces efficiency

Coupled with the unique spiralectrode feature is Buell's Continuous Cycle Rapping—the most effective mechanism yet developed for dry dust precipitation. Completely eliminates puffing, keeps electrodes constantly clean. Re-entrained dust is minimized, peak efficiency is maintained.



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Buell's Low Resistance Fly Ash Collector combines top efficiency with low draft loss, for natural or forced draft installations.

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DUST COLLECTION SYSTEMS

More FREE BULLETINS

Begins on page 165

trated 4-p bulletin 365-1. Associated Research Inc, 3770 W Belmont Ave, Chicago 18, Ill.

26 **Constant potential x-ray,** 250-kv, for studying internal structure of opaque material is described in 11-p booklet XB 404-700. Westinghouse Electric Co, Box 2099, Pittsburgh 30, Pa.

27 **Wire and cables.** Silicone rubber-insulated high-temperature wire and cables are described in 11-p booklet 19-594. Covers listings and specs on power cable, control cable, appliance and fixture wires, apparatus leads, heating cable, generator leads, etc. General Electric Co, Construction Materials div, Bridgeport 2, Conn.

VALVES

28 **Butterfly valves.** Illustrated 14-p bulletin 2 presents facts on characteristics of these units. Henry Pratt Co, 2222 S Halsted St, Chicago 8, Ill.

29 **Condensed catalog** illustrates and describes company's line of bleeder check, boiler feedwater, Venturi reducing, heater bypass, balanced butterfly and atmospheric relief valves. Bulletin V-1, 4-pages. Schutte & Koerting Co, Cornwells Heights, Bucks County, Pa.

30 **Bronze globe valve,** *LQ600*, with *Brinalloy* seats and disks is described in illustrated 4-p bulletin 602. Lunkenheimer Co, Box 360, Cincinnati 14, Ohio.

PUMPS

31 **Controlled volume pumps** for water treating systems. Typical water treating processes described include coagulation systems, lime soda softening, hot process softeners, demineralization, and various types of boiler water treatment systems. Illustrated 24-p bulletin 953. Milton Roy Co, Station E, 1300 E Mermaid Lane, Philadelphia 18, Pa.

32 **Electrifugal pumps** in capacities to 2500 gpm, heads to 400 ft and temperatures to 250 F, are described in 6-p bulletin 52B6083C. Allis-Chalmers Manufacturing Co, 952 S 70th St, Milwaukee, Wis.

33 **Two-stage pumps,** designed in sizes from 2 to 10-in. discharge for capacities to 4000 gpm and heads to 750 ft. Photos, cross-section, dimensions, applications in 4-p bulletin C-1054. C H Wheeler Manufacturing Co, Economy Pumps div, 19th & Lehigh Sts, Philadelphia 32, Pa.

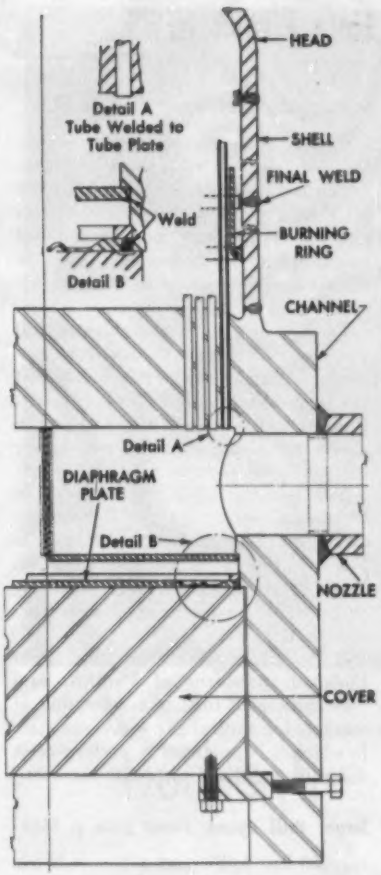
34 **Controlled volume pumps** in paper making. Illustrated 16-p bulletin 455 tells how units are used to meter papermakers chemicals in stock preparation, bleaching, coating, slime and foam control and in water treating. Actual case histories. Milton Roy Co, Station F, 1300 E Mermaid Lane, Philadelphia 18, Pa.

MISCELLANEOUS

35 **Products and services** for the atomic energy industry is subject of illustrated 20-p bulletin 274. Contains data on radiation shielding, reactor components, transfer and storage casks, decontamination cells and remotely controlled manipulation equipment. Farrel-Birmingham Co, Inc, Ansonia, Conn.

36 **Hydraulic cylinders** for pressures to 2000 psi, in 1½ through 13-in. bores; to 22-ft strokes and in 19 different mounting styles. Engr, dimensional, operational, construction, mounting data in 8-p bulletin H-104E. Miller Fluid Power Co, 2040 N Hawthorne Ave, Melrose Park, Ill.

37 **"Water over the dam"** is a 24-p booklet that traces development of American water power from colonial days to emergence of the electric power era. Photos and diagrams. Booklet 02R8232. Allis-Chalmers Manufacturing Co, 952 S 70th St, Milwaukee, Wis.



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THE standard line of Foster Wheeler high-pressure feedwater heaters has now been supplemented with a new *all-welded* design. By eliminating all bolted and gasketed joints, the danger of leakage under thermal shocks is entirely avoided. This means quick start-ups with no need to control the rate of expansion.

Details of the welded shell-to-channel joint, tube joints and diaphragm construction of the new design are shown in the drawing above. All of these welds have been successfully field tested for several years and the design is now available for regular production.

If you have ever been troubled with heater gasket leaks and gasket maintenance, it will pay you to look into this bottle-tight, all welded heater. For detailed information, write to *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

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	Ask for Section Bw	General Purpose Pumps for Handling Liquids Ranging from Fuel Oil to Molasses	½ to 1050 G.P.M.	50 P.S.I. Non-Lubricating Liquids 100 P.S.I. Lubricating Liquids	Complete Range of Materials. Packed or Mechanical Seal. Jacketed Equipment.
	Ask for Section Dw	Heavy Duty Pumps Handle Both Thin and Very Viscous Liquids	10 to 300 G.P.M.	100 P.S.I. Non-Lubricating Liquids 200 P.S.I. Lubricating Liquids	Complete Range of Materials. Packed or Mechanical Seal Jacketed Equipment.
	Ask for Section Dw	Underwriters Pumps Handle All Types of Clean Hazardous Liquids	5 to 300 G.P.M.	90 P.S.I.	Standard Fitted Steel Fitted Bronze Fitted All Bronze Construction. Packed or Mechanical Seal.

Your Viking district office or distributor will promptly furnish complete information on these or many other Viking rotary pumps to fit your needs. Send for any of the above catalogs or check with your Viking distributor.

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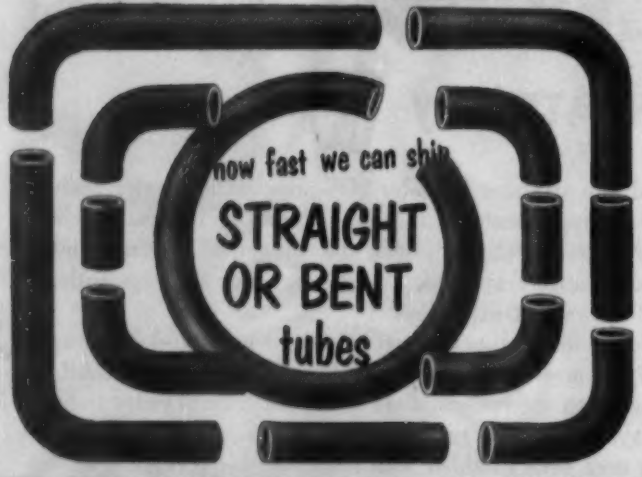

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More POWER NEWS

Begins on page 150

Gas supply deal (*cont from p* 150)

will have no financial interest in the line.

Third, an escalator clause provides for an increase in price to 18 cents per MCF within a few years. Later, it is understood the price may be changed to conform to the "going field price" in the area, as determined by independent investigators.

Fourth, independent evaluators will make periodic reserve checks of the gas-producing area. If there is insufficient gas to provide the full 25-year supply, Phillips and Magnolia are obligated to obtain additional supplies and deliver the gas to the pipeline.

This is the first big intrastate deal in Oklahoma since the 1954 Supreme Court decision subjecting Phillips to Federal Power Commission cont ol. Much of the gas had been originally destined for an interstate pipeline before that decision.

K S Adams, chairman and Paul Endacott, president of Phillips, said "We anticipate further acceleration of markets for natural gas within the state in which it is produced in preference to federally regulated interstate markets."

Sugar mill opens (*cont from p* 150)

ing 900 hp. Individual mill speeds can be collectively or separately controlled by push button from a master panel, permitting instantaneous variations in mill speeds for most efficient performance under varying conditions. Mills may be stopped and started by push button from this remote control panel. Power transmitted from the steam turbines to the mill rolls has four steps of speed reduction.

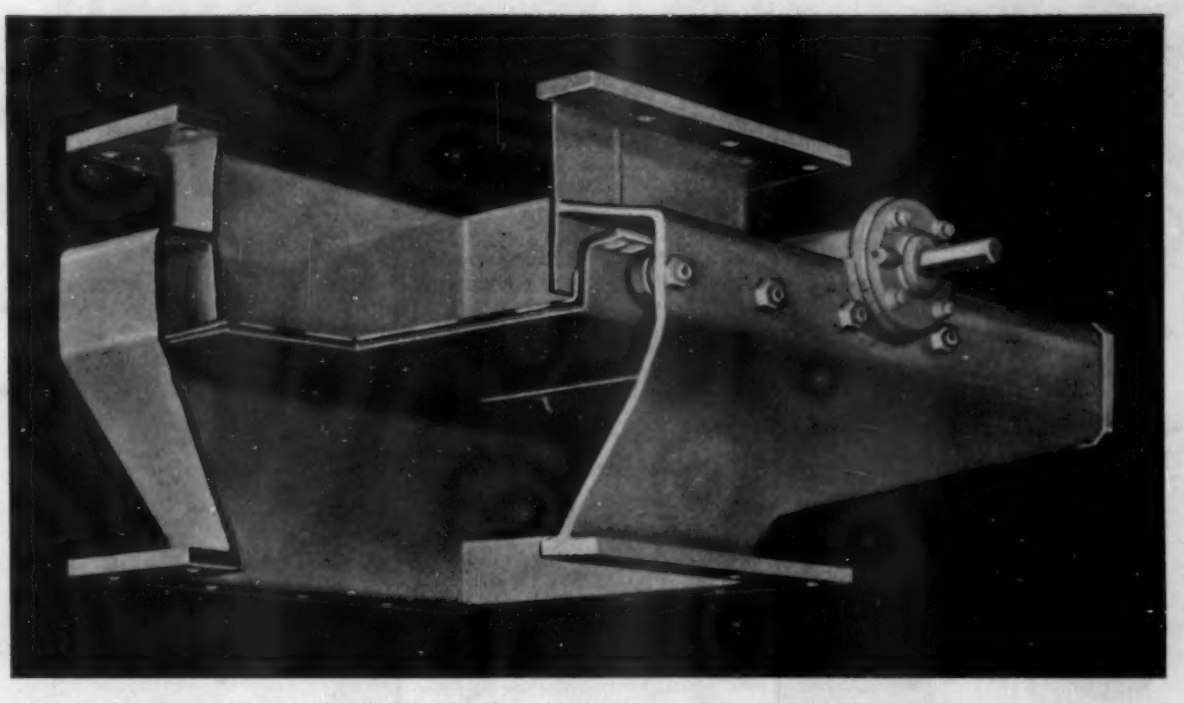
Celebrate 100th anniversary at Crane Company

► CRANE CO, WORLD'S LARGEST manufacturer of valves and fittings, is celebrating its 100th anniversary.

The company had its beginning on July 4, 1855, when Richard Teller Crane opened a one-man, self-built frame shop in Chicago, a city of 75,000 persons. The R T Crane Brass and Bell Foundry, original name of the company, first produced brass couplings and copper tips for lightning rods.

Today Crane Co makes thousands of products including valves, fittings, fabricated piping and piping accessories, plumbing fixtures, and heating equipment. Frank F Elliott is president of the organization.

Crane operates plants at Chicago, Ill.; Chattanooga, Tenn.; Trenton, N. J.;



Here's The Inside Story On The New
S-E-CO. Coal Valve

Strip the ⅜" steel skin off our new coal valve and you'll quickly see why *you get more when you buy S-E-Co.*

First, notice the deep U-shaped gate which completely shields rollers, racks and pinions from coal flow. See how the gate provides lap closure on all four sides assuring positive cut-off. Also, note the stainless steel liner on top side of the gate to combat corrosion.

Carefully formed ladder racks, for their part, are self-cleaning having no root portion in which coal dust can build up and cause jamming. The multi-faced pinions, located above the racks, are also of self-cleaning design. Consequently, the gate moves smoothly with little effort, even after long periods of not being operated.

Notice the clean interior design. Slopes have been kept at a maximum with shoulders and projections eliminated. Even the poke hole covers fit flush with the inside of the valve body so that nothing interferes with flow of coal through the valve.

For a complete list of all the outstanding features of the new S-E-Co. Coal Valve together with installation photographs and dimensions, write for Bulletin No. 97.

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FIG. 29 Cylinder with Impeller

FIG. 17-36 Cylinder

FIG. 215 Flanged

FIG. S-57 Double Window

FIG. 213 Visibility Welding Neck or Screw

FIG. S-811 Flapper

FIG. S-1810 Rotating Wheel Type

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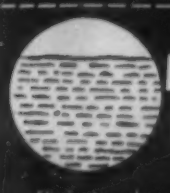

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More POWER NEWS

Begins on page 150

Maumee, Ohio; Colton, Calif.; Montreal, St Johns, Port Hope, Calgary, and Quebec, Canada; and at Ipswich, England. There are 150 branch houses in the U.S. with more than 800 wholesale outlets.

Late in 1953, Crane broke ground for a plant in Chattanooga, Tenn., to produce titanium sponge and ingots. The plant will be operated by a subsidiary company, Cramet Inc. Its dedication will be a feature of the company's centennial observance.

Calendar of Events

July 12-14—Second Western Plant Maintenance and Engineering Show, Pan Pacific Auditorium, Los Angeles, Calif. Full details from WPMES, 759 Monadnock Bldg, San Francisco 5, California.

July 18-20—Sixth Diesel Power Plant Conference, Iowa State College. Complete information from Engineering Extension, Iowa State College, Ames, Iowa.

Aug 15-19—American Institute of Electrical Engineers, Pacific general meeting. Butte, Montana. Details from AIEE, 33 W 39th St, New York 18, N. Y.

Aug 22-23—"Electronics and Automatic Production," national symposium. Sheraton-Palace Hotel, San Francisco, Calif. Details from National Industrial Conference Board, 247 Park Ave, New York, N. Y. or Stanford Research Institute, Palo Alto, California.

Sept 12-14—American Institute of Electrical Engineers, 2nd electrical conference of the petroleum industry. Shamrock Hotel, Houston, Texas. Details from AIEE, 33 W 39th St, New York 18, N. Y.

Sept 12-16—Instrument Society of America, 10th annual instrument conference and exhibit. Shrine Exposition Hall and Auditorium, Los Angeles, Calif. Details from ISA, 3443 S Hill St, Los Angeles 7, California.

Sept 26-30—Atomic Industrial Forum, 1st trade fair of atomic industry. Sheraton-Park Hotel, Washington, D. C. Details from AIF, 260 Madison Ave, New York 16, N. Y.

Three of the largest water-tube boilers in Europe, together with auxiliary equipment, have been ordered by the British Electricity Authority. The order, placed with International Combustion Ltd, London, totals $28 million.

Thirty diesel-powered electric power plants are under construction in Bulgaria. These new plants will produce four times as much electrical energy as all existing Bulgarian plants now turn out.

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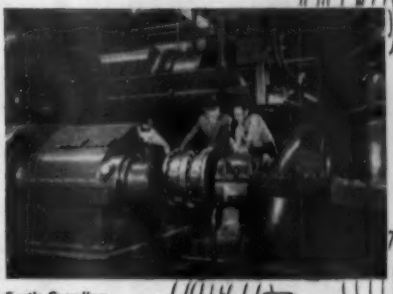

Fast's Coupling installation in a modern power plant.

Close-up of Fast's Coupling, linking power to industrial fan.

Cutaway view of typical Fast's Coupling. Note unique design.

THE ORIGINAL

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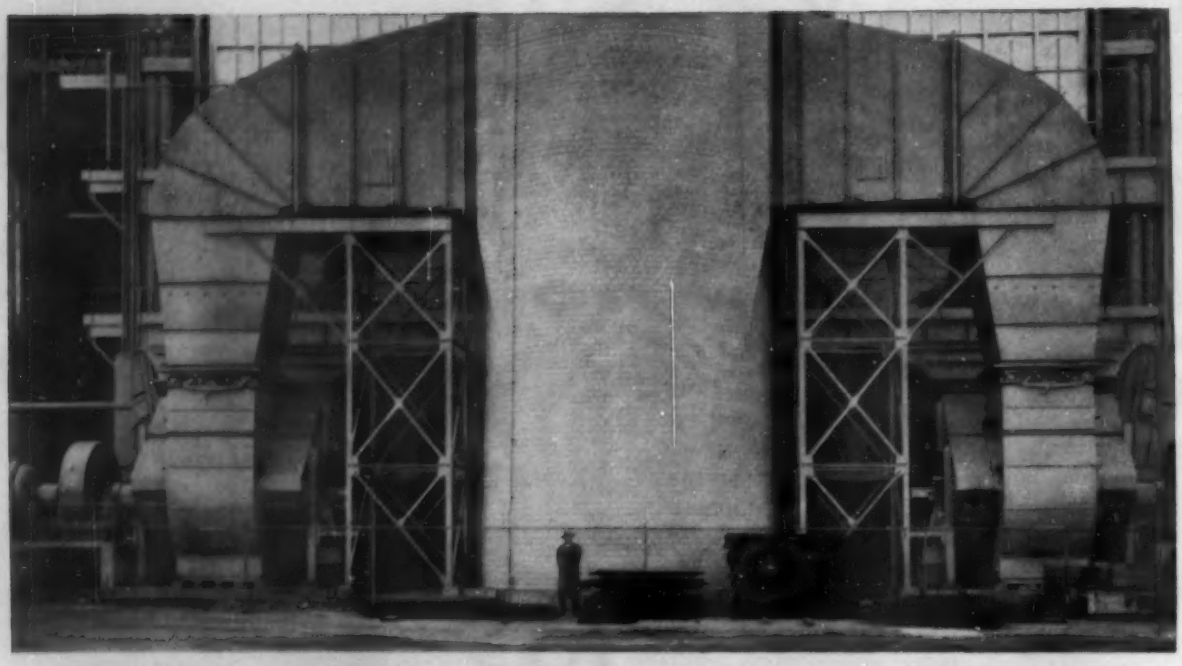

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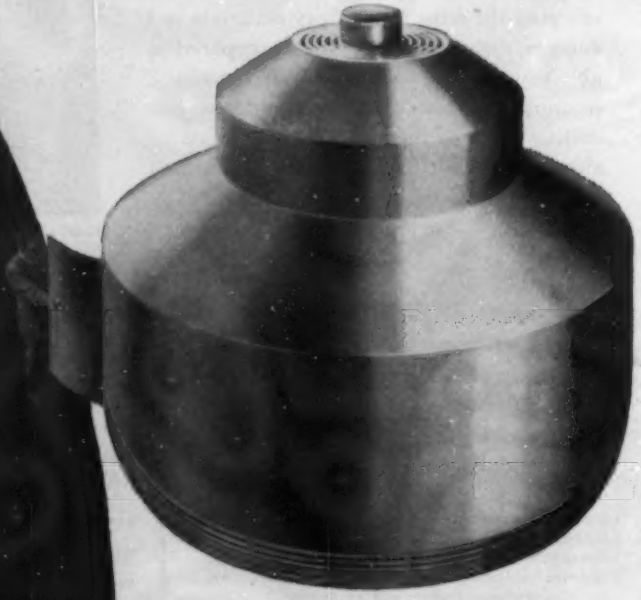

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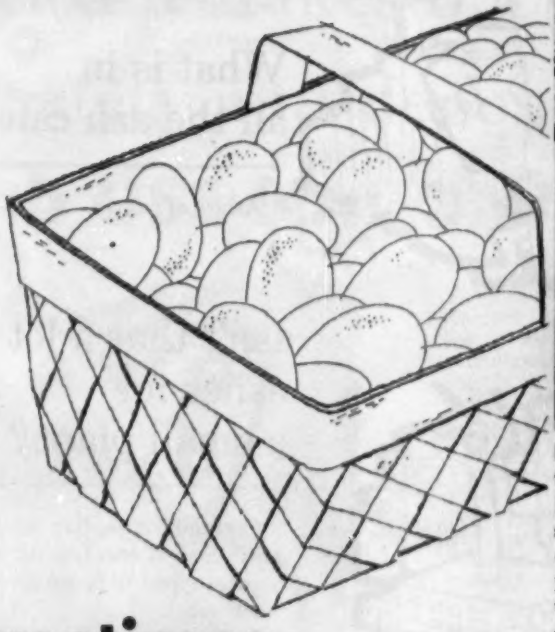
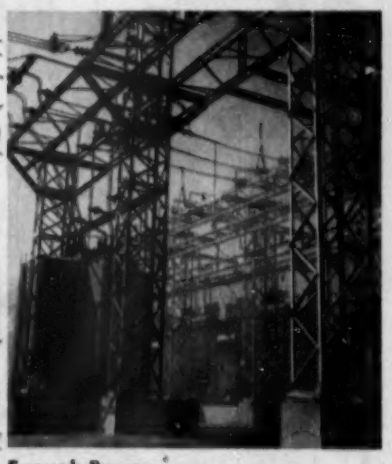
Capsule Case History:





Enough Power for San Francisco is generated, distributed and consumed entirely within the 270 acre site of this major primary aluminum plant. Alternating current from steam turbine generators is rectified to direct current before being distributed by this compact and highly efficient system. Dual circuits under centralized control assure a steady supply of power to all points. Aluminum bus is extensively used throughout the plant.

Kaiser Engineers is equipped to design and build your next power system from generator to point of use.

A power brochure (No. 104), outlining the KE experience in generation and distribution, will be mailed to you upon request.

Sometimes it pays...

Kaiser Engineers, a close-knit team of specialists, is staffed to handle every phase of your project. Their work in widely divergent fields of design and construction offers plenty of proof that it pays to put all your project eggs in this one basket.

kaiser engineers ...for low operating costs

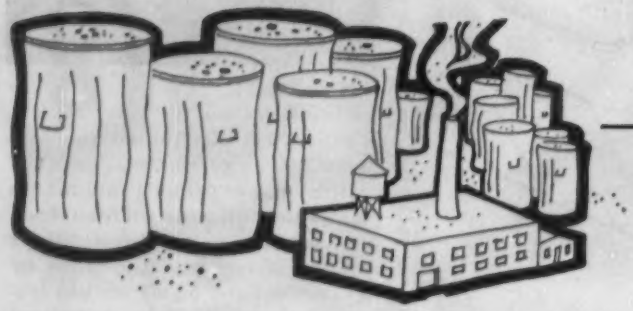
DIVISION OF HENRY J. KAISER COMPANY

ENGINEERS KE CONTRACTORS

• HOME OFFICE: KAISER BUILDING, OAKLAND 12, CALIFORNIA (CABLE: KAISENGS) NEW YORK, PITTSBURGH, WASHINGTON, D.C.
• HENRY J. KAISER CONSTRUCTION CO. • HENRY J. KAISER COMPANY (Canada) LTD., MONTREAL • KAISER ENGINEERS INTERNATIONAL, INC.

What is in all the ash cans?

Ashes, of course.



Isn't that a lot of ashes for a small plant?

Certainly it is, but somebody found a "bargain" coal. It cost less per million BTU's and he never stopped to figure it contained four times as much ash.

It costs money to clean and haul out ashes, doesn't it?

That's not all. Think what we are paying in freight to haul tons of useless ashes from the mine. And all those ashes in the fuelbed cut down boiler efficiency. We don't have the additional steam capacity we had with the better coal.

Intelligent selection of the most economical coal requires careful consideration. It isn't just a matter of price. You should figure the job to be done and the equipment you have to do it. The superior quality coal produced at mines served by the Chesapeake and Ohio will meet our most exacting requirements. Before we sign another coal contract, let's get a C&O coal man in here to give us the facts and figures on which coal will cost us least in the long run.

P.S.

There's a lot more to buying coal than the cost per ton. For facts and figures to solve your particular fuel requirements, write to: R. C. Riedinger, General Coal Traffic Manager, Chesapeake & Ohio Railway Company, Terminal Tower, Cleveland 1, Ohio.

Chesapeake and Ohio Railway

WORLD'S LARGEST CARRIER OF BITUMINOUS COAL

Prudential "takes out insurance" on safety and dependability with USS NATIONAL PIPE

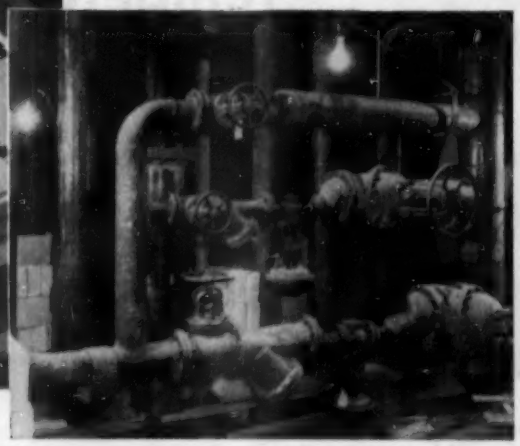
The new Prudential Building, Chicago, Illinois.

The Prudential Insurance Company of America adopted the policy of installing nothing but the best in their new Chicago office building. That's why almost 200 tons of National Steel Pipe were used in the construction of the ultra-modern skyscraper. Here's how the material was used:

- Approximately 120 tons of National Seamless, ranging in diameter from 6 inches to 20 inches, were employed as air conditioning carriers. These "risers" run from the sub-basement to the top floors.
- About 42 tons of National Seamless, ranging from 2 inches to 14 inches in diameter were used for heating and fan rooms.
- About 20 tons of National Pipe, from 1 inch to 3 inches in diameter, help make up the building's plumbing system.

It's no surprise that National Pipe is used in so many of the "big jobs" across the country. Engineers know from past experience that they can depend on National for safe, efficient, trouble-free service.

Write us for further information on the use of National Pipe in air conditioning, heating, and power installations. And, if you'd like some personal assistance with your pipe problems, get in touch with our engineers.



NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS

UNITED STATES STEEL EXPORT COMPANY, NEW YORK

NATIONAL STEEL PIPE

USS

UNITED STATES STEEL

How to Select an Economical Temperature Regulator

First of all, what does economy mean where temperature regulators are concerned? In some industries it means improvement of product or reduction of spoilage through closer control of process temperatures. In others, it means the paring down of operating expense. The price of the regulator itself is a relatively small factor.

Today's buyers are shopping for:

1. Accuracy of control — not only when the regulator is new, but throughout its service life
2. Dependability — to prevent loss of production time
3. Minimum installation and maintenance cost

Here are a few tips on what to look for when you're installing a new or replacing an old temperature regulator —

Packless construction . . . and for this reason: A diaphragm operated, packless regulator minimizes friction. There are no closely fitted parts to stick or bind because of uneven expansion or collection of foreign matter. Also, there's less maintenance, since no repacking is ever required.

A guarantee against wire drawing of the seats and discs. Insist on it. This guarantee in combination with single seat design assures you of tight shutoff; you avoid expensive steam losses as well as loss of product in a process application.

Broad control range. In a standard regulator you should expect a control range of 100 F. And make sure the unit you select has a vapor tension thermostat that can take over-temperatures of at least 100 F.

Easy maintenance. Why ask for grief? Your temperature regulator should be basically simple in design so that it can be serviced by average plant personnel. All parts should be readily accessible for testing and cleaning.

Double duty. There's no point in buying a separate pressure regulator when you can select a temperature regulator that combines both temperature and pressure control within the same unit.

Self-operating. Make sure you get a regulator that operates on its own initial pressure. By doing so, you avoid the purchasing and maintenance of an air compressor plus air piping, and you're sure of uninterrupted operation during electric power failures.

• • • •

All of these points are important to you when it comes to selecting an economical temperature regulator. Perhaps you didn't realize you *could* expect so much. And perhaps you didn't realize that Spence Temperature Regulators offer all these features and more. May we send you our Bulletin T 500 containing further details? SE 150

SPENCE ENGINEERING COMPANY, INC.
Walden, New York

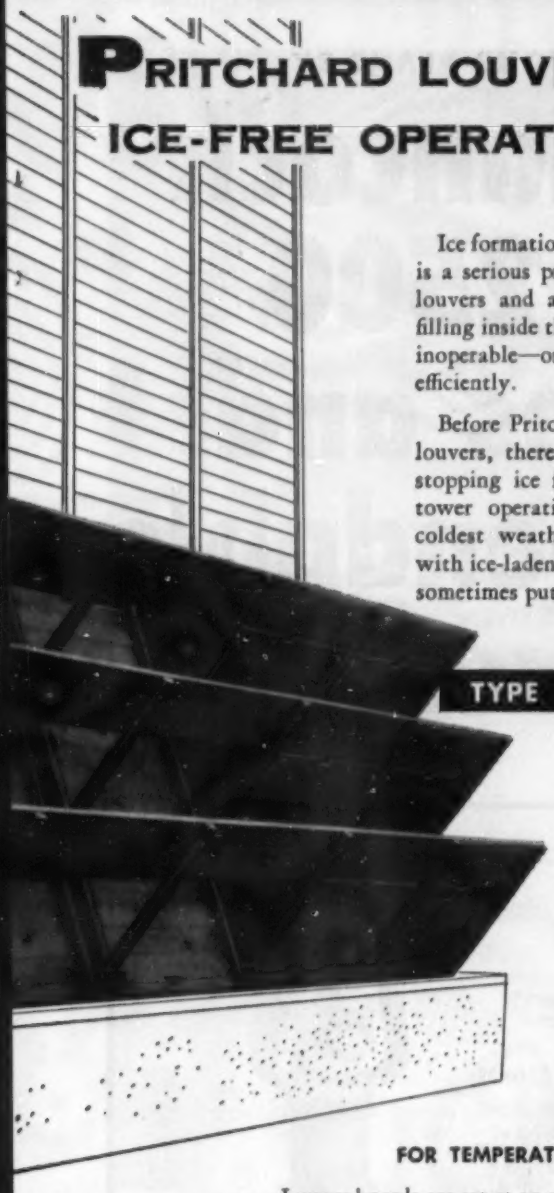
ONE MORE REASON TO CHOOSE PRITCHARD COOLING TOWERS:

PRITCHARD LOUVERS MAKE POSSIBLE ICE-FREE OPERATION IN COLDEST CLIMATES!

Ice formation on cooling tower louvers is a serious problem. Ice can break the louvers and also seriously damage the filling inside the tower. The tower is left inoperable—or, at best, operating inefficiently.

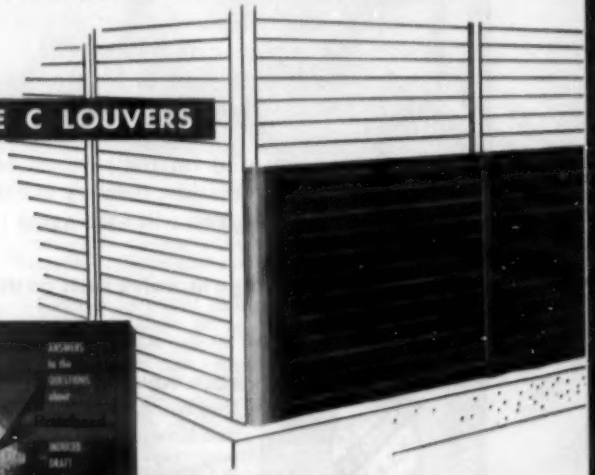
Before Pritchard developed Type WX louvers, there was no effective way of stopping ice formation or keeping the tower operating at peak efficiency in coldest weather. Operators of towers with ice-laden louvers shut off the fans—sometimes putting a canopy over the fan throat—in an effort to melt the ice. But the most they could accomplish was to prevent a further accumulation of ice. And often they couldn't prevent this. Then they tried reversing the flow of air through the tower. This did a partial job of getting rid of ice but also involved the purchase of costly reverse starters for the fan motors.

Now ice formation can be stopped before it starts—with the Pritchard Type WX louvers. One more reason to choose Pritchard!



TYPE WX LOUVERS

Especially designed to eliminate ice formation in extremely cold weather operation. Wide louvers are supported in a frame set out from the tower to prevent splashing water from reaching the louvers and forming ice. Each louver is individually hinged, can be opened or closed to regulate air flow into the tower, thus controlling water temperature and stopping ice formation. The WX louvers can be shut off on the windward side, leaving the louvers on the other side open. In this way the tower can continue to function efficiently without danger of freezing. The entire operation can be done from the ground, adding safety and convenience.



TYPE C LOUVERS

FOR TEMPERATE CLIMATES

Louver boards are set at an angle on close centers vertically and are supported by slotted louver posts set close to the tower. All boards are individually removable for easy access to the basin. This design makes possible a neat, compact tower with minimum basin requirements.

INDUSTRY'S PARTNER FOR PROGRESS

COOLING TOWERS
GAS & AIR TREATING EQUIPMENT

REPRESENTATIVES IN PRINCIPAL CITIES FROM COAST TO COAST

J.F. Pritchard & Co.
OF CALIFORNIA
A DIVISION OF J. F. PRITCHARD & CO.
Dept. 488, 4625 Roanoke Parkway, Kansas City 12, Mo.

NEW PRITCHARD INDUCED DRAFT COOLING TOWER BROCHURE

This new Pritchard brochure answers 15 questions about Pritchard Induced Draft Cooling Towers. Completely illustrated. Each feature described in detail. Large, cutaway drawing takes you inside a typical Pritchard tower. Interesting, informative. Send for your complimentary copy today on your company letterhead!

SAVE MONEY AND PROTECT YOUR PLANT BY

Installing Hancock 1500# and 2500# Steel Valves and assuring dependable leak-proof service

Put an end to the costly hazards of valve leakage in your high-pressure, high-temperature steam plant! Let proved-in-the-line Hancock 1500# and 2500# Valves assure the safe, reliable performance so essential to protect personnel, plant and service to customers.

Hancock 1500# and 2500# Steel Valves are preferred by most design and operating engineers in modern steam plants for very practical reasons. There is no bonnet joint to leak, no gasket to leak, no seat insert to leak! In fact, these rugged valves have every design, quality and construction feature essential for the severest services. Get complete information, then try one of these heavy-duty valves. You will soon agree that . . .

When Hancocks go in, valve costs go down!

SIZES:

¼" through 2"
Outside Screw
and Yoke

SERVICE RATINGS:

Screwed and Socket Weld Ends: For all pressures up to 2500 psi at 1050° F., O.W.G. 6000 psi—100° F.

Flanged Ends: For all pressures up to 1500 psi at 900° F., O.W.G. 3600 psi—100° F.

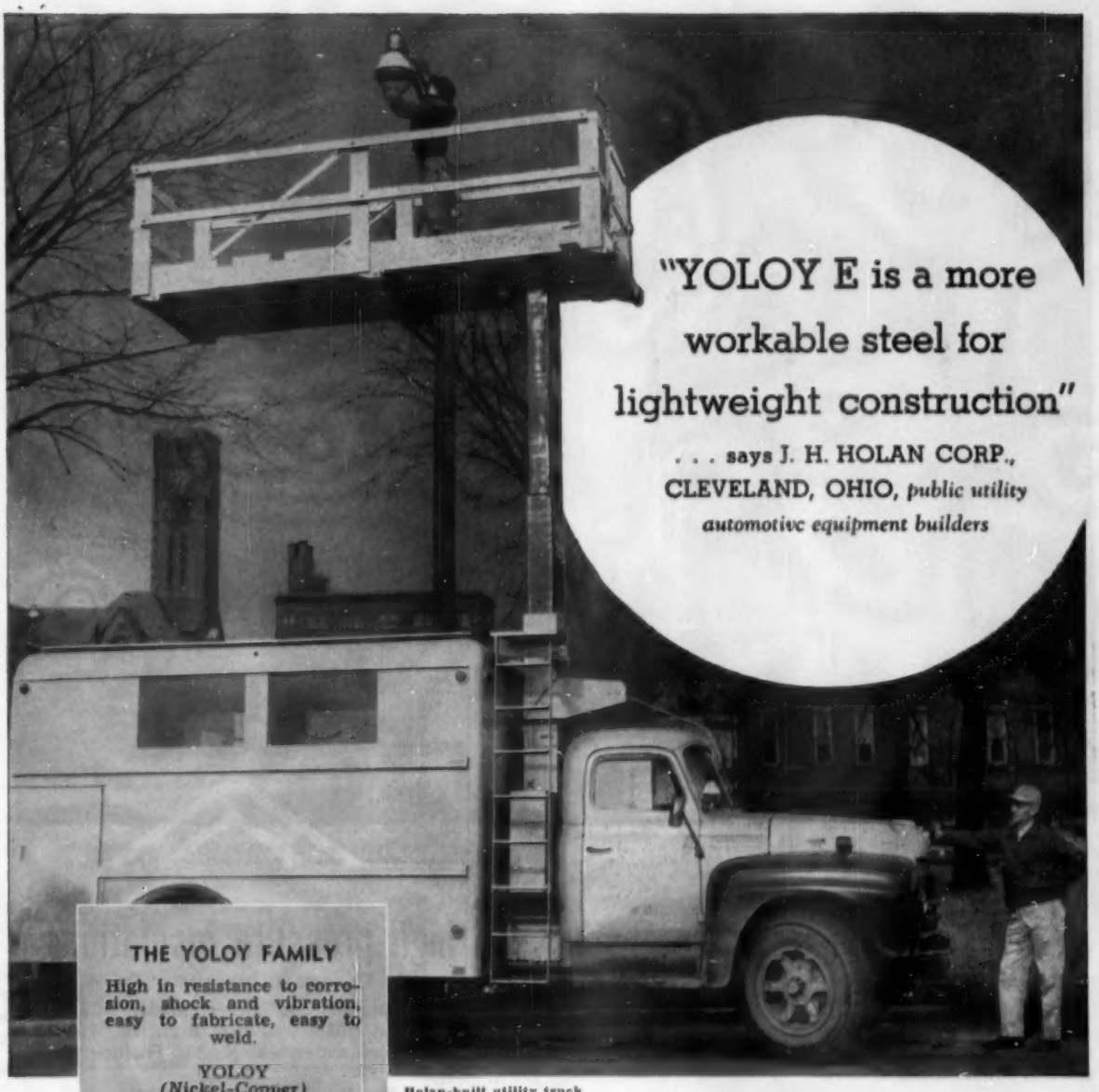
YOUR INDUSTRIAL SUPPLY DISTRIBUTOR is as close as your telephone. You can depend on his recommendations and service to save you time, trouble and expense.

In Canada: *Manning, Maxwell & Moore of Canada Ltd., Galt, Ontario*

HANCOCK VALVES

A product of **MANNING, MAXWELL & MOORE, INC.** Watertown 72, Massachusetts

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN-MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, Stratford, Conn. 'CONSOLIDATED' SAFETY RELIEF VALVES, Tulsa, Okla. AIRCRAFT CONTROL PRODUCTS, Danbury, Conn. and Inglewood, Calif. "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, Muskegon, Mich.



"YOLOY E is a more workable steel for lightweight construction"

. . . says J. H. HOLAN CORP., CLEVELAND, OHIO, *public utility automotive equipment builders*

THE YOLOY FAMILY

High in resistance to corrosion, shock and vibration, easy to fabricate, easy to weld.

YOLOY
(Nickel-Copper)
Low Alloy High Strength Steel

YOLOY E
(Nickel-Chrome-Copper)
Low Alloy High Strength Steel

YOLOY C
(Chrome-Copper)
Corrosion Resistant Steel

Holan-built utility truck body fabricated from Yoloy E steel.

QUALITY YOUNGSTOWN SERVICE

● This utility body builder finds Yoloy E—Youngstown's low-alloy high-strength steel—an important time-and-money saver and product improver.

They report that Yoloy E is an easily "workable" steel. Once brake dies are set, there is remarkably little breakage and scrap.

Truck users also benefit. The high strength of Yoloy E permits the use of lighter gauge in bodies and equipment, providing reduced weight and increased payload. The exceptional rust-and-corrosion-resistance lengthens equipment life, reduces maintenance.

For information about Yoloy steels, write our nearest District Sales Office.

Youngstown

THE YOUNGSTOWN SHEET AND TUBE COMPANY *Manufacturers of Carbon, Alloy and Yoloy Steel*

General Offices: Youngstown, Ohio • District Sales Offices in Principal Cities

SHEETS - STRIP - PLATES - STANDARD PIPE - LINE PIPE - OIL COUNTRY TUBULAR GOODS - CONDUIT AND EMT - MECHANICAL TUBING - COLD FINISHED BARS - HOT ROLLED BARS - BAR SHAPES - WIRE - HOT ROLLED RODS - COKE TIN PLATE - ELECTROLYTIC TIN PLATE - RAILROAD TRACK SPIKES

A COMBINATION INSULATION. A 2 inch thickness of K&M Hy-Temp, together with a 2 inch thickness of K&M "Featherweight" insulates the pipe and main throttle valve shown. This equipment at the Meramec Power Plant, Union Electric Company of Missouri, St. Louis, operates at 950°F. Insulation Contractor: Armstrong Cork Company.

More steam at less cost with K&M high pressure insulations

Heat losses are kept to a minimum when K&M Insulations are used. Steam holds its temperature . . . users get the dollar savings that come from highly efficient conservation of heat.

K&M "Featherweight"® 85% Magnesia and K&M Hy-Temp Insulation last the life of the equipment they serve. They withstand moisture, vibration, and frequent temperature changes. Both are supplied in various sizes and thicknesses. These materials, when used together, and applied so that joints are staggered, eliminate the heat loss that normally occurs in single-layer installations—particularly when expansion causes joints to open. K&M insulations are widely used—in power stations, hospitals, steamships, food processing plants—wherever and whenever exacting steam temperature control is a must.

Efficiency to 1900°F. K&M Hy-Temp Insulation is used on applications where temperatures rise to 1900°F. It's made of diatomaceous silica combined with heat-resistant mineral fillers and asbestos fiber. Usually, it's applied in combination with K&M "Featherweight" 85% Magnesia.

Efficiency to 600°F. K&M "Featherweight" 85% Magnesia is used for effective insulation of piping and equipment with temperatures up to 600°F. 85% of this material is composed of basic carbonate of magnesia, the remainder of asbestos fiber.

Where severe water exposure may damage insulation, or where high humidity and moisture are present, K&M "Featherweight" Water-Resistant Magnesia is especially effective. It withstands temperatures to 450°F.

Don't delay—act today! When you save on heat losses, you save on operating expenses. For further information—and the name of your K&M distributor, who is an experienced applicator, write to Keasbey & Mattison Company.

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

K&M best in asbestos®

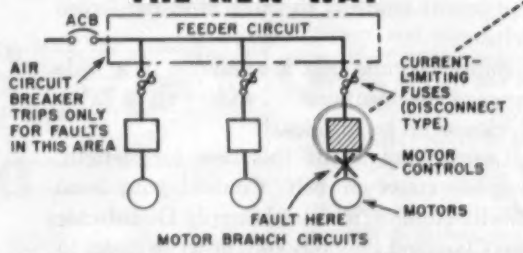
IN CANADA: ATLAS ASBESTOS COMPANY, LIMITED, MONTREAL, TORONTO, WINNIPEG AND VANCOUVER

NOW... low-cost short-circuit protection for large, low-voltage motors with E-M HI-FUSE LOW-VOLTAGE CONTROL!

● This simplified E-M Control, lower in cost than equivalent circuit breaker protection, brings to users of low-voltage motors an impressive series of advantages:

1. **HIGH INTERRUPTING CAPACITY**... 100,000 rms ampere interrupting capacity, plenty for future expansion as well.
2. **CURRENT-LIMITING**... disconnect type fuses minimize magnetic and thermal stresses on control components.
3. **FAST ACTING**... faults are interrupted in ½ cycle or less; 100% availability with no adjustments needed.
4. **COORDINATED PROTECTION**... includes fuse interruption on short circuits and overload relay trip on normal overloads.
5. **"BULL'S EYE" SELECTION**... only the faulted circuit is interrupted. See diagram below.
6. **MINIMUM MAINTENANCE**... there is nothing to wear out. Only occasional routine inspection required.

THE NEW WAY



MOTOR BRANCH CIRCUITS

When you have E-M Hi-Fuse, Low-Voltage Control on duty, you don't need to depend on a feeder circuit breaker, which would shut down all motors to clear a motor branch circuit fault. Instead, fuses in the E-M Control safeguard each branch circuit, clearing faults almost instantly while other motors continue in service.

One low-cost integrated unit!

E-M "pre-engineers" control components, arranging them together simply and effectively in one compact enclosure. You get complete, unified, dependable protection for motor and personnel at low cost! Ask your nearest E-M sales engineer for further information, and write the factory for Publication No. 218.

ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

E-M 3300-TPA-2177

Specialists in **PROTECTIVE CONTROLS FOR ELECTRIC MOTORS**

NEW SUPER RAYNILE CONVEYOR BELT 400% STRONGER

Provides the economical answer to transporting coal and other bulk materials over long distances and up steep slopes.

This remarkable new Hewitt-Robins conveyor belt reinforced with the revolutionary synthetic fabric, Super Raynile, makes possible an entirely new concept in single-section conveyor application. It solves difficult materials handling problems where topography and other conditions require the use of a long single-length conveyor.

Already in service, Super Raynile has the highest operating tension of any conventional carcass belt. Because of its tremendous tensile strength, 400% greater than conventional cotton reinforced belts, a single conveyor section *5¾ miles long* can be built over level terrain to carry material at 400 TPH using only a 6-ply Super Raynile belt 30 inches wide. This same belt can also lift material from ground level to a height of 830 feet.

The new Hewitt-Robins Super Raynile conveyor belt is highly flexible and pliable despite its great strength. Its cost is less than steel-reinforced belts and Super Raynile can easily be spliced in the field more quickly, more economically and without the specialized equipment required to splice steel-reinforced belts.

Super Raynile belt is available in a wide range of specifications . . . widths up to 72"—thickness up to 15 plies.

Learn more about this new long-length, long-life conveyor belt. Contact your local Hewitt-Robins Industrial Supply Distributor (see Classified Phone Book), or write direct to "Super Raynile Belt", Hewitt-Robins Incorporated, Stamford, Connecticut.

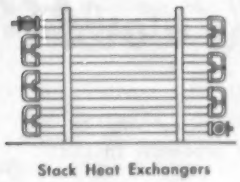
Hewitt-Robins

Conveyor Belting—Industrial Hose—Conveyor Machinery—Vibrating Screens—Vibrating Conveyors—Design, Manufacture, Engineering and Erection of Complete Bulk Materials Handling Systems.

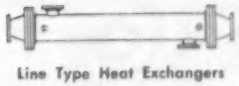
HEWITT-ROBINS INCORPORATED • STAMFORD, CONNECTICUT

Another reason why,
EBKO *is best for complete piping service . . .*

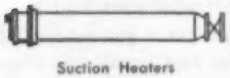
EBKO piping systems can save you thousands of dollars



Stack Heat Exchangers



Line Type Heat Exchangers



Suction Heaters

• EBKO custom designed piping systems are the absolute highest of quality, made with the finest of materials, sold at competitive prices. The keynote of EBKO design is simplicity. Here are some reasons why EBKO should be your first and last choice:

INSTALLATION EASE. EBKO pipe is built stronger than any other prefabricated pipe. Long lengths can be assembled on the ground and raised or at the side of the trench, then lowered. No special handling methods or tools and no special structural supports are needed.

DURABILITY. Never has an EBKO prefabricated piping system failed. EBKO piping joints, both *interior* and *exterior*, can be tested and visually checked after each is assembled. Before you backfill the trench you know the job is sound.

ENGINEERING SERVICE. EBKO engineers will give job-site service prior to and during installation. These are highly trained, experienced men in all phases of piping.

DELIVERY. The simplicity of EBKO design means complete systems can be assembled and shipped in the very minimum of time.

NATIONWIDE SERVICE AND SALES. Factory representatives in every major city are located throughout the United States to answer any question that may arise.

. . . there are many, many more reasons why EBKO should be your first and last choice. Call your local EBKO Representative and let him show you how to cut your piping system costs. Write for details—no obligation.

Cast Iron Steel

EBKO
Complete Prefabricated Piping Systems

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FOR STEAM • HIGH TEMPERATURE WATER • CHILLED WATER • VISCOUS LIQUIDS

Where would you get condenser tubes...

...for the longest Steam Condenser in the world?

Jersey Central Power & Light Co. has what is reported to be the world's longest steam condenser in the Raritan River station, Sayreville, N.J. For this huge job, they chose *Chase* 60-foot Cupro-Nickel condenser tubes.

Good reason for this! Years and years of valuable condenser tube experience, coupled with modern, expert research facilities, have made Chase a leader of long standing in this field!

Specialists in the Chase Research and Development Group are constantly testing and experimenting—fighting corrosion problems in the laboratory and in the field.

Shipped from Chase mills in Waterbury, Connecticut and Cleveland, Ohio, literally millions of pounds of Chase Condenser Tubes have passed the toughest test of all—dependable, trouble-free service on the job! Like Jersey Central Power and Light Company, you, too, can add extra years to condenser tube life. *Simply insist on Chase!*

Prompt Delivery from Cleveland and Waterbury Mills

Chase®

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Boston	Dallas	Indianapolis	Newark	Providence	Waterbury
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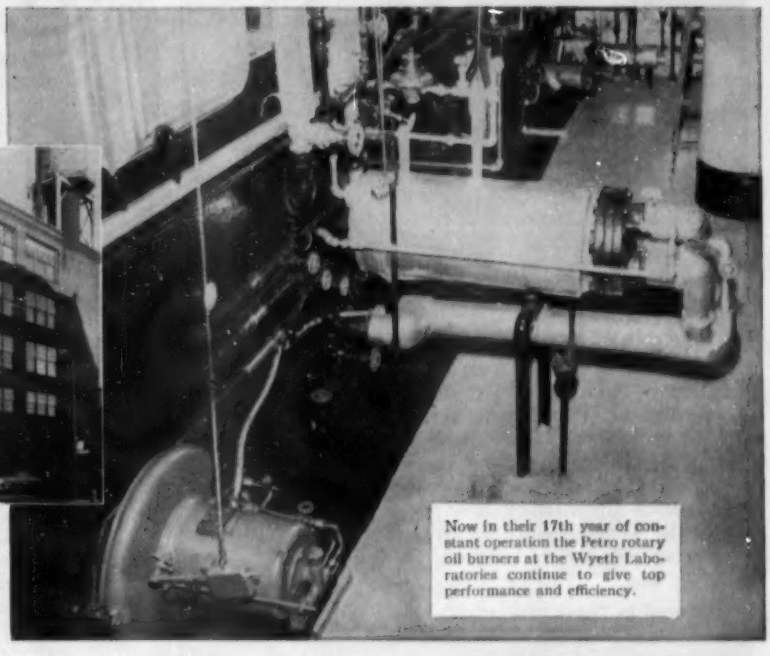
Petro Industrial Oil Burners

PAID FOR THEMSELVES DURING THE FIRST YEAR

for the

WYETH LABORATORIES, INC.
Philadelphia, Pa.



Now in their 17th year of constant operation the Petro rotary oil burners at the Wyeth Laboratories continue to give top performance and efficiency.

"Petro oil burners saved us $6,349 on fuel the first year—and in addition we enjoy better heating and more horsepower from our boilers," says E. C. Beeler, Plant Engineer.

FUEL SAVINGS JUST DON'T HAPPEN —there has to be a reason—and the Petro "Thermal Viscosity System" is the reason Petro equipment owners all over the country save thousands of dollars every year! It's a simple, foolproof fuel preheating system which lowers the viscosity of the low-cost, heat-rich heavy oils and enables users to burn them with complete reliability.

Here's how it works

To properly fire No. 6 oil, the oil must be *warmed* so that it will thin out and ignite easily and atomize efficiently. To accomplish this vital need Petro burners have a magnetic valve which is controlled by the oil temperature and will not admit oil to the rotary atomizing cup until it is warm enough to fire properly. The oil is circulated through automatic heaters until the proper temperature is reached. Heaters are of ample capacity to supply warm oil for any firing need.

Thus Petro oil burners assure owners (1) accurate metering of oil (2) fine, thorough atomization (3) quick starts, no smoky fires (4) no slug of cold oil in lines to cause faulty starts.

No manual attention is required

The entire operation is automatic. There are no involved mechanical controls requiring adjustment or maintenance.

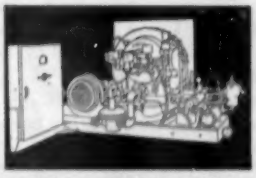
Saves labor costs—saves fuel costs

Why don't you find out how much Petro industrial oil burners can save for you? They are quickly adaptable to nearly every existing boiler. Send in the coupon for full information.

OVER 50 YEARS OF LEADERSHIP IN AUTOMATIC HEATING AND POWER EQUIPMENT

PETRO

T.M. REG. U.S. PAT. OFF.



COMPLETE PACKAGED UNIT

A complete forced draft combustion system with all parts factory assembled and tested. Saves installation time and cost, gives top performance and fuel economy.

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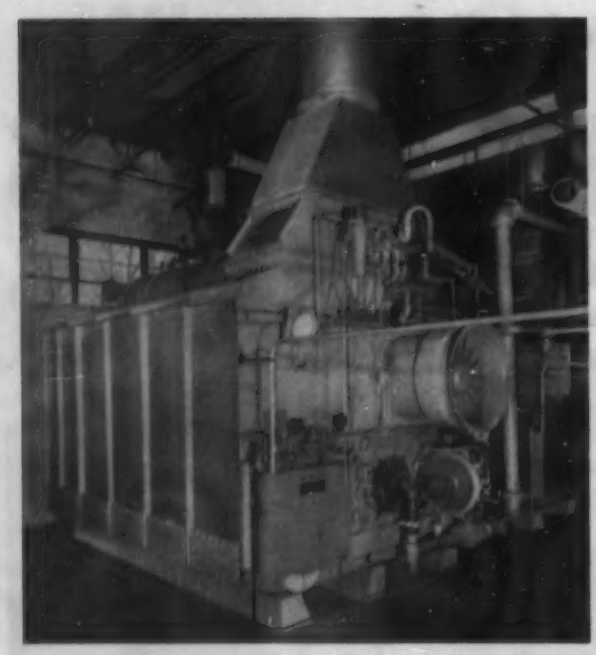
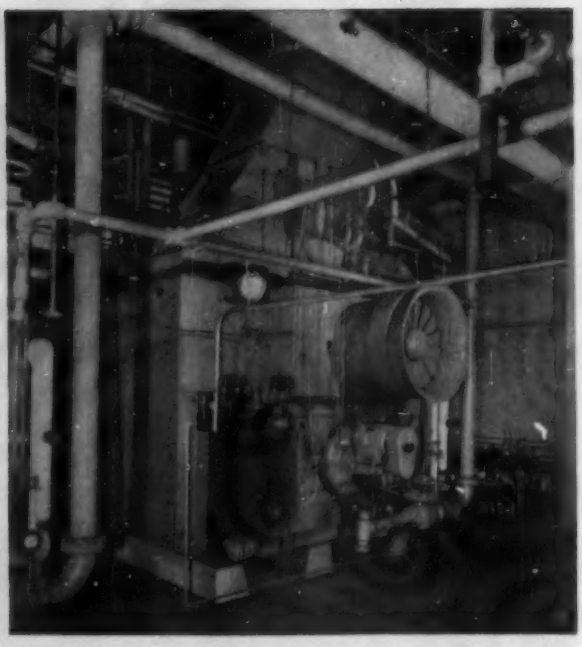




Union packaged boiler twins perform two key jobs for modern mid-west feed plant

Job Report (UIW)—Side by side in the Springfield, Missouri plant of Consolidated Products Company, two Union Type "MH" Packaged Steam Generators play a dual role in the manufacture of livestock and poultry feeds. They produce steam for processing milk by-products and for building heat.

Reported to "have proven very satisfactory and dependable sources of steam" by Consolidated, these packaged units were completely shop-assembled by Union Iron Works in Erie, Pa. before shipment to their midwest job site. Each of the pair has a steam capacity of 22,500 lbs. per hour and is equipped for burning heavy oil or gas.

Stressing the selection of MH Steam Generators "on the basis of good design," Consolidated Products Co. adds, "Union Iron Works had previously given us excellent service on several coal-fired, water tube boilers."

From Oregon to Alabama, Union Type MH Steam Generators have been installed in breweries, chemical processing plants, pulp and paper mills, refineries, schools and institutions, to name but a few.

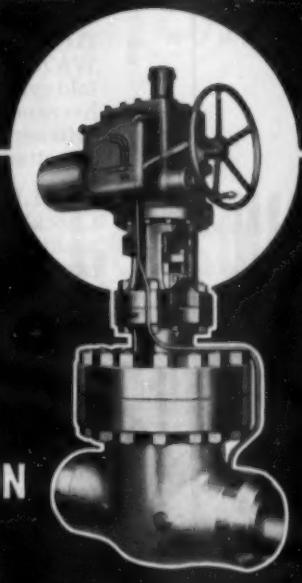
Patterned after larger but similar field erected Type H Boilers, originated by Union over 16 years ago, shop-assembled MH Units can be equipped to handle multitudes of needs formerly requiring costly field erection and special engineering. Superheaters can be installed to meet total temperature requirements, while both air heaters and economizers are readily supplied when needed.

Standard units are designed in 13 sizes from 10,000 to 40,000 lbs. of steam per hour at 250 psi, with higher pressures available for special applications.

The complete story on Union Type MH Steam Generators, including cut-away illustrations, tube layouts and dimension tables, can be obtained promptly by requesting Bulletin MH-353 from Union Iron Works, Erie, Pa.

VACUUM CONDENSING EQUIPMENT inside Springfield plant utilizes steam produced by MH Units to process milk by-products.

SPRINGFIELD BLENDING PLANT — One of 38 plants operated by Consolidated Products Co. to produce livestock and poultry feed.



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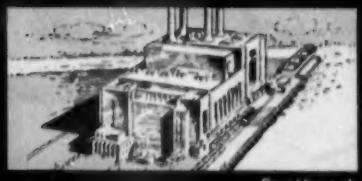

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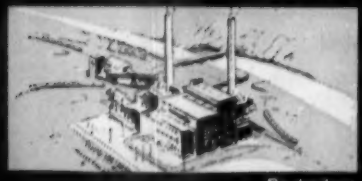
Richmond



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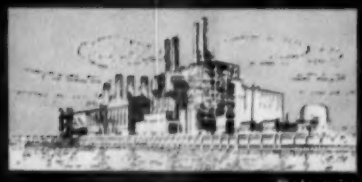

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Lagging Public Construction — A Spreading National Blight

The most recent editorial in this series dealt with the plans of American industry for expanding and modernizing its plant and equipment over the next four years. These plans call for the expenditure of $113 billion over that period. There is a good prospect that the money to carry them out will be available. If the plans are carried out, manufacturing capacity at the end of 1958 will be double that which existed at the end of World War II. And this industrial plant will be modernized.

In sharp contrast to this picture is the condition of our *public* plant and equipment — the roads, schools, water supply, health and sanitation facilities upon which industry, as well as the average family, depends. **According to a recent estimate by the Twentieth Century Fund, the people of the United States must spend almost $100 billion on new public works projects during the next five years merely to meet the minimum needs of our growing economy.**

Other estimates by the President's Council of Economic Advisers, by state agencies and by private construction economists all show the same condition: a staggering need for public works. Yet no steps have been taken that even offer a promise of closing the gap between the public facilities we are building and the greater facilities we really need.

How did we come to let our public facilities fall into this sorry state? Here are some of the reasons:

(1) During the years of depression and war, from 1930 to 1945, these facilities were neglected. New construction declined, and even maintenance was cut.

(2) Since the end of World War II, increased construction costs have made it difficult for communities to get the needed construction with the funds budgeted in the past for that purpose.

(3) The great postwar upsurge in population, and the spreading of our population into new areas, has created a huge demand for additional community facilities before the neglect of earlier years could be made up.

Responsibility Divided

Now the need for more public construction has become apparent to everyone, on jammed highways and in over-crowded schools. But, unfortunately, the responsibility for doing something about this situation cannot be so clearly fixed as can the responsibility for maintaining industrial facilities. A business firm must expand its capacity when markets are growing or lose its trade position. It must modernize its plant and equipment or be undersold by more efficient competitors. In the case of public facil-

ities, there is no such competitive incentive. To be sure, a city or state may lose population and industries if its public facilities are inadequate. But such shifts are very slow to take place and difficult to relate to any specific public program, or lack of it.

Moreover, the responsibility for constructing public facilities is divided between state and local governments and federal authorities. Within each of these governmental units there are specialized bureaus or departments with varying responsibilities. This division of responsibility obviously adds an element of difficulty to the development of an adequate program of public construction.

Breaking the Log-Jam

How can this administrative log-jam be broken and the financial difficulties overcome?

One course would be to have the federal government step in with a nation-wide new program of direct spending on public works. That would utilize the resources of the federal treasury for immediate action. But there are weighty objections to such extensive federal participation. One is that federal spending cannot be greatly enlarged without a corresponding increase in the federal control of decisions that normally have been left to local communities. Another objection is based on the fact that so long as we must maintain a large defense establishment, such an addition to federal spending means either higher taxes or a chronically unbalanced budget.

The other course is to rely primarily on local initiative, but with new and more effective federal aid to local governments. Such aid would help speed up planning and construction, and contribute toward a solution of the most burdensome financing problems, but in amounts sufficiently limited to require that most of the capital be raised locally.

No Single Formula

No one formula can be applied to make such aid effective. The raising of funds for new schools, for example, involves problems very different from those of financing highways, or water-works, or hospitals. But it does seem clear that, in all these fields, the federal grants must be designed to stimulate more local planning and financing than has prevailed in the past. Among the new ideas that may offer such incentives are federal grants for planning and initial costs and federal guarantees of local bond issues. Such aids have been remarkably effective in the fields of slum clearance and public housing.

While the federal government clearly has a role to play, we cannot afford to postpone inauguration of an adequate public construction program while we seek a formula to apportion governmental participation that would be generally accepted as ideal. Every year about 2½ million more Americans are putting increasing pressure on a public plant already dilapidated and inadequate. The result is an increasing menace to comfort, health, education and safety. It is also an increasing menace to the effective performance of American industry.

The appropriate public response to this situation is a driving public determination to eliminate this increasingly dangerous lag in public construction. At this juncture, the development of such a determination is basic. Nothing stands in the way of an adequate program of public construction that a determined electorate cannot remove.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments that are of particular concern to the business and professional community served by our industrial and technical publications.

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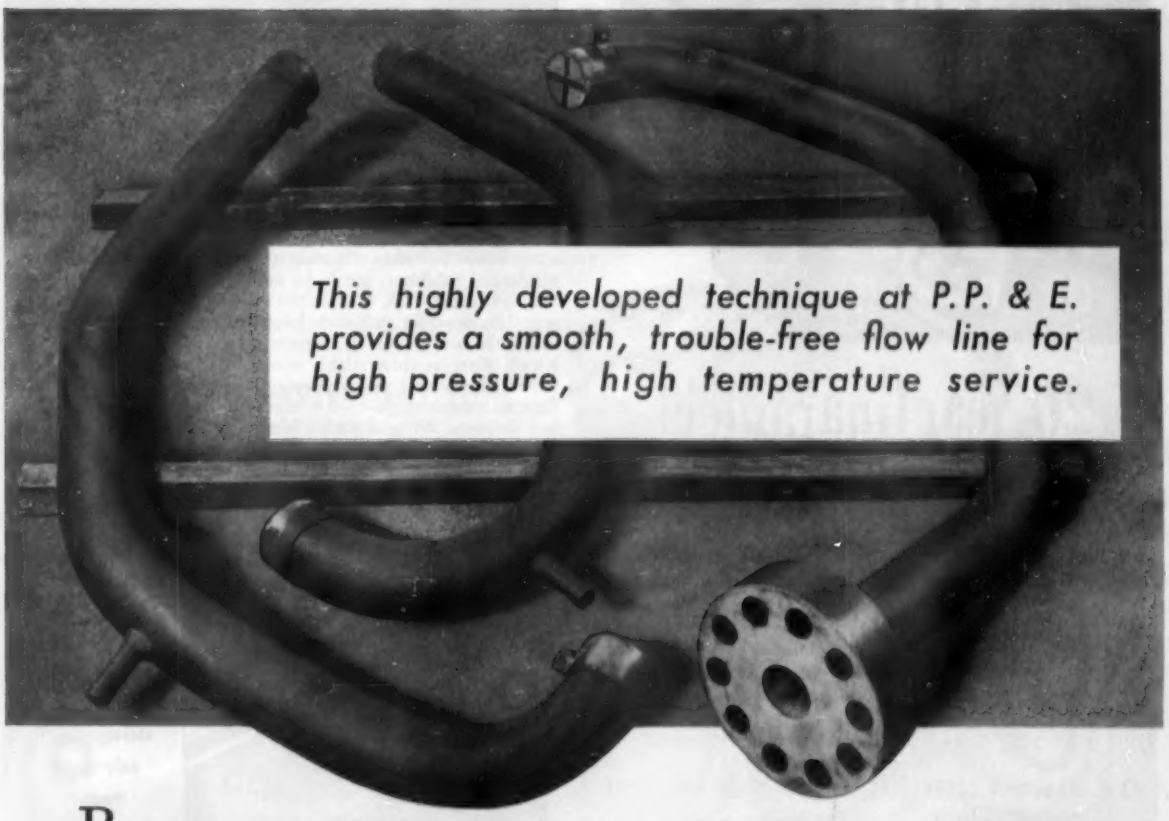
Hot Bending at Pittsburgh Piping



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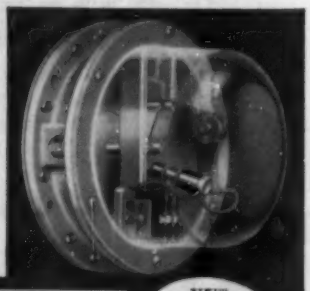

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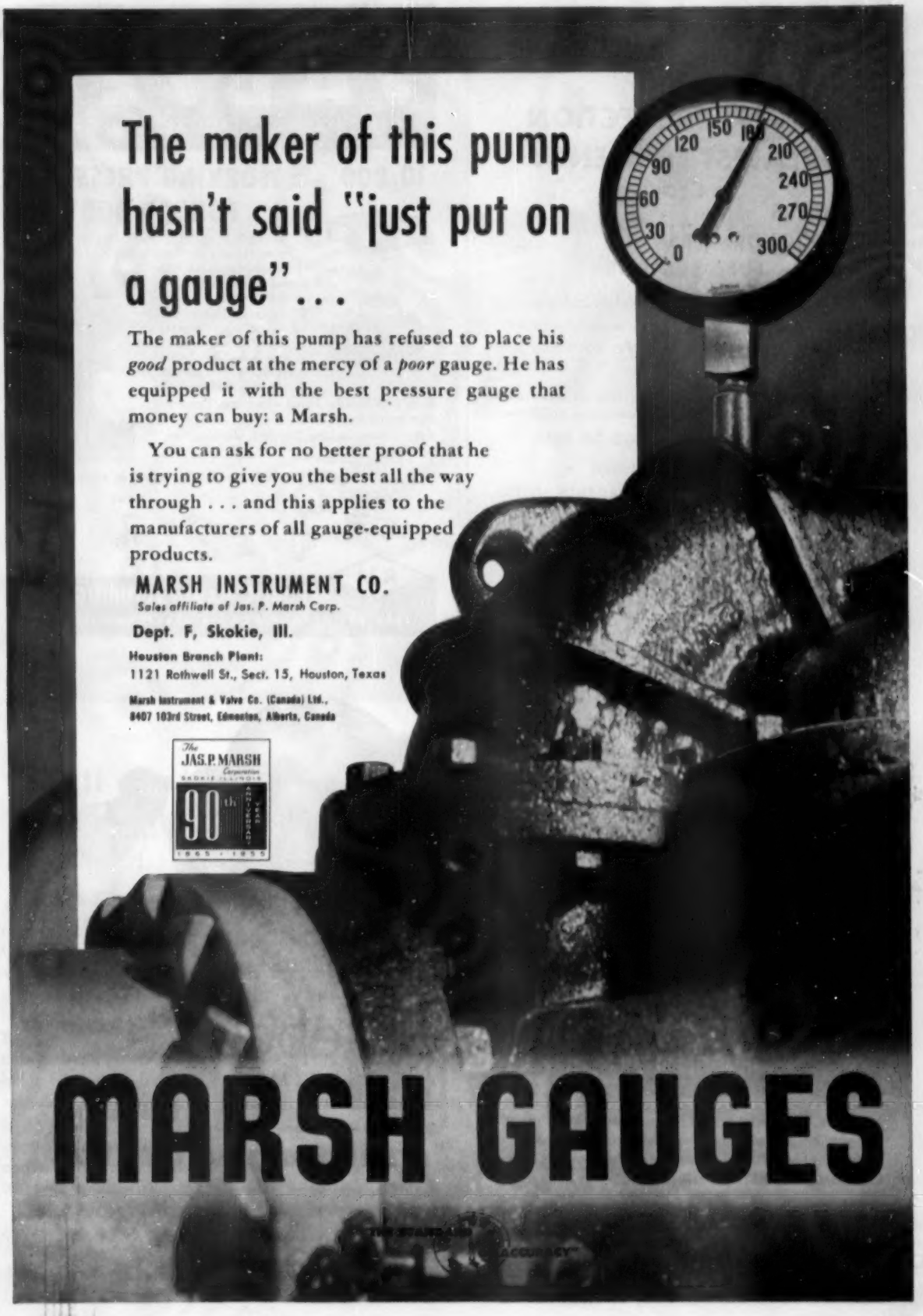

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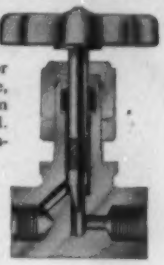

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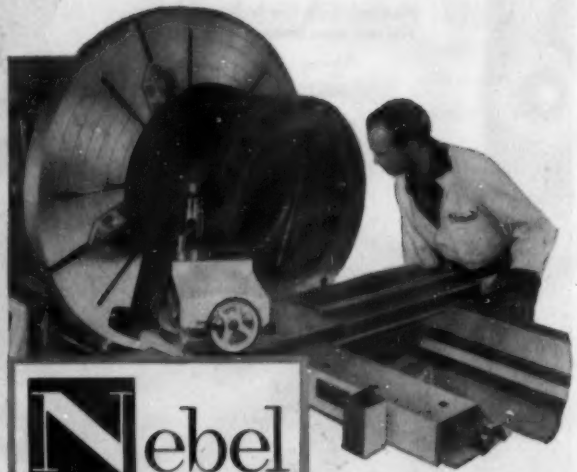

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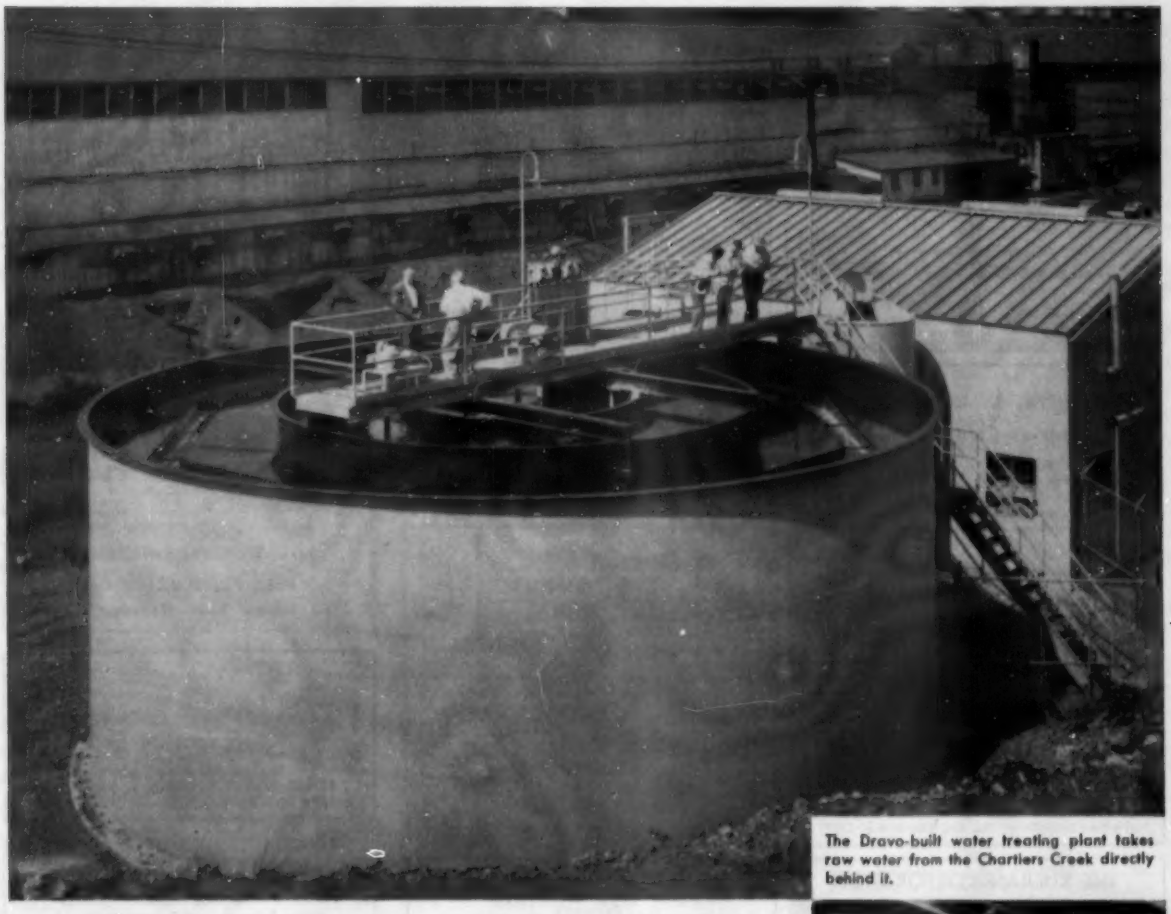

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ELECTRICAL ENGINEER — TRAINEE

To assist supervisor in Maintenance and construction work in a sizeable mid-western educational institution. Applicant should have a degree from an accredited engineering school and preferably some practical experience. Employee benefits include a pension plan, paid vacation, sick leave, etc

P-6836, POWER

520 N. Michigan Ave., Chicago 11, Ill.

WANTED

APPLICATION & TEST ENGINEERS

FLUID MECHANICS, M. E. graduate (or equivalent education) for design, research and application of flow measurement and control components. Salary commensurate with experience.

P-6690, POWER

330 W. 42 St., New York 36, N. Y.

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42 St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITION VACANT

Mechanical Engineer—Experienced M.E. with degree to take complete charge of power plant for large Midwest dairy. Age 27 to 35 with 5 years in power plant; capable of engineering, selecting equipment and maintaining steam, refrigeration, electrical generation equipment and distribution systems. Write complete qualifications in first letter, including references and salary desires. P-6617, Power.

EMPLOYMENT SERVICE

Salaried Personnel, $3,000-$25,000. This confidential service established 1927 is geared to needs of high grade men who seek a change of connection under conditions assuring, if employed, full protection to present position. Send name and address only for details. Personal consultation invited. Jira Thayer Jennings, Dept. G, 241 Orange St., New Haven, Conn.

POSITIONS WANTED

Power Plant Superintendent, age 33, married, technical education, 10 years experience in the operation and maintenance of steam-electric power plants. Understands personnel problems. PW-6009, Power.

Mechanical Engineer college graduate, age 39, 18 years experience in supervision, operations, and maintenance of power generating plants. Presently employed as chief engineer of steam-electric generating plant. Valid reasons for desiring relocation. Excellent references including that of present employer. PW-6834, Power.

Mechanical Engineer, age 38, B.S.M.E. Wide experience operation high pressure central station, large demineralizer units, hot process water treatment, combustion control instruments. Design experience and plant betterment. Desire station superintendent or responsible position utility or large industrial. PW-6839, Power.

SELLING OPPORTUNITIES WANTED

Manufacturers Representative, New York City area. Power, refinery, chemical plant equipment. Two graduate M.E.'s with wide experience and excellent contacts offer exceptional representation to one additional quality manufacturer. RA-6817, Power.

Manufacturers representatives with graduate engineers in offices in Dayton, Cincinnati and Louisville desire to represent one additional company in the power plant and industrial fields. Company must have some current business and large sales potential. RA-6730, Power.

SEARCHLIGHT SECTION

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Discount of 10% if full payment is made in advance for 4 consecutive insertions.
The advertising rate is $17.90 per inch for Equipment & Business Opportunity advertising appearing on other than a contract basis.
Employment Opportunities, $25 per inch, subject to agency commission.
An advertising inch is measured ⅞ vertically on one column, 3 columns—60 inches—to a page.

New Ads: Send to 330 W. 42nd St., New York 36, N. Y. for August issue closing July 6th.

WANTED

INSTRUMENTATION ENGINEERS

Engineers with M. E. degree or equivalent background for steam power control equipment design, application and service. Experience desirable, but not mandatory.

P-6687, POWER

330 W. 42nd St., New York 36, N. Y.

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Home Heating	Math Tables	Physics
Illumination	Metals	
Electrician's Data	Trig-Log Tables	Metallurgy
Builder's Data	Gen'l Chemistry	Hydraulics
Lumber Data	Chemical Tables	Radio
Air Conditioning	Analytic Chem.	Television & FM
Building Constr.	Mech'l Drawing	Electricity, AC
Reinf. Concrete	Machine Design	Electricity, DC
Piping Data	Machinist's Data	AC Motors & Gen'trs.
Surveying	Mech. of Materials	
Surveying Tables	Pwr. Trans. Mech.	Transformers, Relays & Meters
Highway Eng'g.	Thermo. Tbls.	

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LEFAX PUBLISHERS, Dept. PO-8, Phila. 7, Pa.

OFFICIAL PROPOSALS

POWER AUTHORITY OF THE STATE OF NEW YORK
ADVERTISEMENT FOR PROPOSALS FOR
ALTERATIONS AND REPAIRS TO THE MASSENA-TAYLORVILLE TRANSMISSION LINE, NEW YORK

NOTICE TO CONTRACTORS: The POWER AUTHORITY OF THE STATE OF NEW YORK will receive sealed proposals for the Alterations and Repairs to the Massena-Taylorville Transmission Line, New York, in the following ways:

(1) If brought in person on the day of receiving bids, until 2:30 P.M. Eastern Daylight Saving Time on the 12th day of July, 1955, 270 Broadway, Hearing Room C on the 6th Floor, New York, New York.

(2) If mailed in, until 2:15 A.M. Eastern Daylight Saving Time on the 12th day of July, 1955, at the Authority's office, 270 Broadway, Room 1300, New York 7, New York.

The proposal will be publicly opened and read aloud at the time and at the address given in (1) above.

Bids will be entertained for furnishing the equipment and services and performing the work in accordance with the bidding schedule. Completion of the work will be required on on before January 1, 1957.

Plans, specifications and Proposal Forms for the work will be on file in the Authority's office and in the offices of the Engineer, Uhl, Hall & Rich, 230 Congress Street, Boston 10, Massachusetts, may be inspected by prospective bidders during office hours, and may be obtained from the Power Authority of the State of New York, 270 Broadway, Room 1300, New York 7, New York, upon application and prepayment of a fee of ten ($10.00) dollars per initial set of contract drawings and five ($5.00) dollars per set for additional sets, no part of which will be refunded. Two sets must be returned with each bid.

Bids must be made in duplicate upon the Proposal Forms included in and bound with the Contract Documents. Each proposal must be accompanied by a draft or certified check payable to the order of the Power Authority of the State of New York for the sum of $50,000.00.

The right is reserved to reject any and all bids.

W. E. CHAPIN
GENERAL MANAGER

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The successful applicant will assist in specification of power equipment and in selection of new facilities, and will make economic evaluations and involved heat balances for complicated power systems.

Duties will include determination of causes of equipment malfunctioning and development of recommendations for corrections.

Please send complete resume including details of education and experience to:

Mr. J. C. Costello, Jr.
Personnel Section
Engineering Department
E. I. du Pont de Nemours & Co., Inc.
Wilmington 98, Delaware

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Age limit 45 preferably about 35. Must be graduate mechanical, chemical or civil engineer with natural mechanical ability, excellent practical and supervisory and some construction experience, for charge under Chief Engineer of all shops, foundry, mobile equipment including loading, marine, railway and construction; maintenance and repair of all types of equipment; 7250 KVA diesel generating plant.

Forward with initial reply complete educational and experience records, list of references, age, marital status, number and age of children, photo (optional). Company offers three year contract, furnished house, transportation self and family, liberal vacations. Excellent climate, living conditions, medical and hospital facilities. School to 14 years. Non-contributory pension plan. Salary open.

P-6780, POWER
1111 Wilshire Boulevard
Los Angeles, California

O'Brien Offers—

MOTOR GENERATOR SETS

1—500 KW Crocker Wheeler CCD, 250 volt 720 RPM with 750 KVA Cr. Wh. Syn. Motor 3/60/2300 V. A.C. & D.C. Panels.
1—500 KW West. 3 wire 125/250 Volt 1200 RPM Generator (1933 year). Can furnish with suitable motor. Advise Requirement.
2—250 KW Burke 125 V. 435 KVA Syn. M.D. 3/60—any voltage
1—150 KW G.E. Type MPC—250 Volt 1200 RPM 3/60/2300/200 H.P. Syn. Motor Drive A.C. & D.C. Panels
1—100 KW G.E. BC 17, 125 v. 3/60/220/1200 rpm
1—100 KW Al. Ch. 250 V, 1200 RPM 150 HP. Syn. Mtr. 3/60 or 3/60 any voltage.
1—75 KW Burke 250 V. 900 RPM 115 H.P. Burke—Syn. M.D. 2 or 3 ph, any voltage.
1—62½ KW 125 volt Hertner, 1200 rpm, 100 HP Sq. Cg. 3/60/220
1—60 KW G.E. 250 V. 1200 RPM 90 HP 220/3/60/SYN.

DIESEL GENERATOR SETS

3—625 KVA Inger. Rand, 3/60/480/720 rpm
2—488 KVA GM-Winton 3/60/2300/360 rpm
1—375 KVA GM 8-268 Diesel 3/60/2400
3—200 KW GM Diesels Twin 671—3/60/220/1200 RPM
1—300 KW GM 8-268 Diesel 125/250 V. D.C.
3—100 KVA Cooper Bessemer 3/60/440
1—67.5 Kato 3/60/220 Continental Gas
1—25 KVA LeRoi Gas 1/60/120/240
1—10 KW Wincharger 1/60/110-220 Gasoline

BOILERS IN STOCK

2—40,000 Lb. C.E. Package 400 P.S.I. Oil 1944
2—25,000 Lb. C.E. Package Oil 250 P.S.I. 1953
2—800 H.P. Cleaver Package Oil 150 P.S.I.
1—300 H.P. Superior Package Oil 125 Lb. 1954
1—150 H.P. O & S Package Gas-Oil 15 Lb. 1952
1—800 H.P. Superior Package Oil 15 Lb. 1950
1—100 H.P. Clayton Oil 160 Lb. New
1—80 H.P. Clayton Oil 160 Lb New
4—15 H.P. Columbia 150 Lb New
1—9 H.P. Columbia 150 Lb. New

ELECTRIC MOTORS

QU.	HP	Make	Type	Volts	Speed
1	500	West.	CS	6600/2300	514
1	450	A.C.	ANY	2300	600
1	400	West.	CW	440	514
1	400	G.E.	Syn.	2300	450
1	350	G.E.	MT18	2300	400
2	200	West.	CW	2300	1800
1	200	G.E.	I.M.	440	514

JUST PURCHASED
3—300 H.P. General Motors Twin 6-71 Radiator Cooled Heavy duty Diesel Power Units New 1952—used 200 hrs.

TURBO GENERATORS

1—11250 KVA G.E. 3/60/13200/3600 rpm—Condensing—Boilers—Complete Plant

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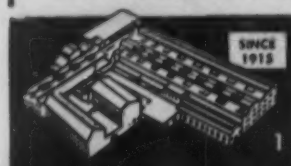
2—4000 KVA Allis Chalmers 3/60/2300/3600 rpm—Condensing
1—1250 KVA DeLaval Non-Cond. 3/60/2300. New 1940 240 psi 50 lb. B.P.
1—938 KVA GE-Terry Aut. Extr. 3/60/480 150 psi. 20 lb. B.P. Surf. Condenser 1934
1—780 KVA G.E.-Moore 3/60/2300/3600 RPM Non-Cond. 180 PSI 35 lb. B.P. New 1936.
1—75 KW G.E. Non-Cond. D.C. 125 volt.

AIR COMPRESSORS

1—1600 cfm IR PRE-2 Syn. Mtr. Dr. 3/60/2300—100 psi.
2—1300 cfm IR-PRE-2 3/60/2300—100 psi
1—1040 CFM Chicago Pneumatic, GCB, Syn. Mtr. Dr. 3/60/220/100 PSI
1—978 CFM Sullivan 13x13x8, 45 psi.
1—900 CFM C.E. 17x10x12—M.D. 3/60/220
1—371 CFM Schramm 7¼x5x4. 100 psi
1—368 CFM I.R. 12x10, 100 P.S.I.
1—284 CFM Ing. Rand #50 Type 40, V-Belt Drive 50 H.P. 3/60/440 125 PSI
1—178 CFM Chicago NSB 100 psi

OISC TRANSFORMERS

Qu.	KVA	Make	Pri. V.	Sec. V.	Phase
3	2000	G.E.	13200	230/460	1
3	1000	GE	13200	2300	1
1	1100	West.	4160	440	3
1	750	O'Brien New	13200	480	3
3	667	Al. Ch.	33000	2300	1
3	500	Wagner	33000	2400/4160Y	1
1	500	Gregory	4160	440	3
3	400	GE	2400	480	1
3	333	Pitts.	33000	2300	1
3	333	G.E.	13800	240/480	1
3	250	Al. Ch.	13,200	115/230	1
3	250	Penns.	34500	120/240	1
3	167	G. E.	12000	2400	1
3	150	G.E.	13200	2300/4000Y	1
3	150	West	2300	230/115	1
3	100	G.E.	13200	120/240	1
3	100	West.	4160	240/480	1
3	25	Atlantic	2400	240/120	1



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SLIP RING MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Speed
600	2200	Whse.	450
500	2300/4000	G. E.	900
450	440	Whse.	514
450	440	Whse.	720
300	2300/440	G. E.	720
300	440	G. E. (hoist)	600
300	2300	G. E.	360
300	440	Whse.	3600
200	440/220	Whse.	600
200	550/440	G. E.	1200
200	440/220	Whse.	514
150(2)	440/220	G. E.	720
150	2300/440	G. E.	600
125	440/220	G. E. (hoist)	600
125	440/220	G. E.	900
125	550/440	G. E.	1200
100	440/220	G. E.	720
75	2300	G. E.	600

SYNCHRONOUS MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2300/440	G. E.	ATI	720
375	440/220	Whse.	G	900
350	440/220	Bl. Mach.	Syn.	1200
250	2300/440	G. E.	TB	720
250	2300/440	G. E.	TB	1200
250	2200/440	G. E.	TB	720
250	440/220	Whse.	HR	277
250	440/220	G. E.	ATI	600
125	440/220	Whse.	HR	600

SQUIRREL CAGE MOTORS

H.P.	Volts	Make	Type	Speed
600	2300	G. E.	PC	3600
500	2300/4000	Elliot	SC	1800
500	2300	G. E.		450
400	2300/400	Whse.	CS	720
300	2300	L. Allis	PS	1800
225(2)	2300/440	G. E.	KT	1200
200	440	G. E.	IK	720
200	440/220	G. E.	KT	1800
200	2300/440	G. E.	IK	600
200	2300	G. E.	KT	1800
150	440/220	Whse.	CS	900
150	2200	Al. Chal.	AR	1800
150	220	Whse.	CS	1200
150	440/220	G. E.	IK	600
150	440/220	G. E.	KT	720
150	2300/440		KT	900

A. C. GENERATORS

1—320 kva, 900 rpm 2300/440/220 V., G. E.
1—300 kva, 900 rpm, 440/220 V., G.E.
1—225 kva, 60 rpm, 220/440 V., G.E.
1—200 kva, 720 rpm 2300/440 V., G.E. (Ball)
1—187 kva, 1200 rpm, 2200/440 V., Whse.

CIRCUIT BREAKERS

2—2000 amp. GG E., 3 pole, 600 V.
2—1600 amp. FTE, 3 pole, 600 V.
6—FKB-155-28, 600 amp., 15,000 V., G.E.
1—FKB-143, 1200 amp., 4500 V., G.E., Sol. op. (new)

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
225	230	Whse.	BK	2870
150	230	Whse.	BK	1750
100	230	Whse.	BK	400/1200
50	230	G. E.	CD	1750

MOTOR GENERATOR SETS

KW	Make	Input V., AC	Motor Type	Output V., DC
200	Whse.	2300	Syn.	250
175	G. E.	220/440	Syn.	230
125	G. E.	440/220	Syn.	250/125
100	Al. Ch.	220/440	sq. cs.	240/120
100	Whse.	440/220	sq. cs.	125
75	G. E.	2200/440	Syn.	125
65	G. E.	2300/440	sq. cs.	250

TRANSFORMERS 60 Cy.

1—600 kva, Standard, 13,800-2300 V., 3 ph.
3—500 kva, Whse., 44000—2300 V.
3—333 kva, G. E., 12000—2300 V.
3—200 kva, G. E., 2300—575 V.
3—200 kva, G. E., 11000—2300 V.
3—200 kva, G. E., 4150—480/240 V.
3—150 kva, Al. Chal., 2400—240/480 V.
6—100 kva, Whse., 2400—120/240 V.

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86 CFM 100 psi Worth HB
93 CFM 100 psi 7x6 IR-Penn-Sull
105 CFM Worth (gas) portable
142 CFM 125 psi 6/8/5x3 Ingersoll Type 40—25 Elec
160 CFM Worth (gas) portable
188 CFM 125 psi 8½x3 Worth
211 CFM 100 psi 9x3 Ing. Rand ESI
234 CFM 100 psi Worth HB
254 CFM 100 psi 10x10 Ingersoll ER-1 40 HP Elec
268 CFM 300 psi 10/4½x10 Ingersoll 75 HP Synch
278 CFM 125 psi 2 stage Chicago PD-30 HP Elec
294 CFM 125 psi 10x11 Worth—HB
343 CFM 500 psi 11/5x13 Worth Elec or steam
354 CFM vacuum 14x5 Ing
380 CFM 125 psi 12-7½x10 Penn
460 CFM 125 psi 15/9x10 Ingersoll XRB—Duplex
500 CFM Chicago (Diesel) portable
526 CFM 100 psi 14x12 Ing ERI
550 CFM Vacuum 17x6 Chicago
676 CFM 125 psi 15/9½x12 Ingersoll XRB—Duplex
720 CFM Vacuum 18x7 Worth HB
931 CFM 35 psi 17x15 CPT Elec or steam
1035 CFM 35 psi 20x12 Penn-3A 100 HP Elec
1104 CFM Vacuum 22x8 Penn TAT
1292 CFM 35 psi 20x15 Chicago T-8 125 HP Elec
1331 CFM 125 psi 18½-11½x8½ Worth YC2
1374 CFM 100 psi 22-14x16 Ing PRE2 250 HP
1681 CFM Vacuum 24x12 Chic. T8
1723 CFM 110 psi "XPV" 4 corner Ing. steam
[illegible] CFM 40 psi 28-28x27 Ing PRE 1 700 HP
Nash Hytors L-3, H-7, H-8

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COMBINATION MILL DRIVES — 15/2500 HP
D.C. MOTORS WITH M.G. SETS & CONTROLS

		MAKE	TYPE	VOLTS	R.P.M.
2500	HP	Whse.		600	600
2000	KW	G.E.	Syn.	2300/4600	450
2200	HP	G.E.	MCF-12	600	400/500
2000	KW	G.E.	Syn.	2300/4600	450
900/					
1400	HP	G.E.	MCF14	280/600	40/83/190
1500	KW	G.E.	Syn.	6600/13200	720
1250	HP	Whse.	Rev.	600	300/600
1000	KW	G.E.	Syn.	2300/4600	720
1250	HP	G.E.	MCF	600	750/900
1000	KW	G.E.	Syn.	2300/4600	720
1000	HP	G.E.	MCF-8	600	350/700
1000	KW	G.E.	Syn.	2300/4160	720
500	HP	Whse.	Mill	600	300/900
500	KW	Whse.	Syn.	2300	1200
350	HP	Whse.	Mill	250	350/950
300	KW	Whse.	Syn.	220/440	1200
200	HP	G.E.	CD-1650Z	250	500/1500
200	KW	Cr. Wh.	Syn.	6600/13200	1200
200	HP	Whse.	CR-511.3	250	400/800
200	KW	El. Mach.	Syn.	220/440	1200

ALSO MANY OTHER COMBINATIONS

A. C. MOTORS—3 Ph. 60 Cy.

SLIP RING

Qu.	H.P.	Make	Type	Volts	Speed
1	1500	G.E.	MT-493	2300	360
1	1500	ABB		2300	720
1	1000	A.C.	MH	2300	240
1	800	G.E.	MT	2300	293
1	700	Al. Ch.	D.P.	2300	500
1	500	G.E.	MT-412	2300	880
1	500	G.E.	M-574Y	6600	900
1	500	Whse.	CW	550	550
1	400	Whse.	CW-960A	440	1170
1	400	Whse.	CW	440	514
1	400	Whse.	CW-1218	2300	435

SQUIRREL CAGE

2	600	G.E.	PT-550RY	440	2570
1	500	G.E.	K-6345S	2300	1185
2	450	Whse.	CS-1470	2300/4150	884
1	400	G.E.	1E-15B	2300	1165
1	300	Whse.	CS	440	1170
1	200	G.E.	IK-17	440	880
3	200	G.E.	KT-557	440	1800
1	150	Whse.	CS-856B	440	880
1	150	Whse.	CB	440	880

SYNCHRONOUS

1	4350	C.W.	8501-8L	13800/6900	514
2	2100	G.E.	ATI	2300	900
2	1750	G.E.	ATI	2300	3600
2	3000	Whse.		2300	120
2	725	G.E.	ATI	2300/12000	600
1	500	Ideal	SM	2300/4160	1800
1	500	G.E.	TS-756T	2300	1200
1	450	Whse.		2300	450
1	400	G.E.	TS	2300	400

M-G SETS—3 PH. 60 CY.

Qu.	K.W.	Make	RPM	DC Volts	AC Volts
2	2000/2400	G.E.	450	250/300	2300/4600
1	2000	G.E.	450	600	2300/4600
1	2000	G.E.	600 2Reg	600	11000
2	2000	G.E.	514	600	6600/13200
1	1750/2100	G.E.	514	250/300	4000/2400
1	1500	G.E.	720	600	6600/13200
1	1500	C.W.	514	30/115	4000/13000
2	1000	G.E.	720	600	2300/4600
1	1000	G.E.	600	300	6600
1	750	C.W.	514	30/115	2300
1	750	G.E.	600	125/250	2300
1	600	G.E.	720	250	440/2300
1	500	Whse.	1200	115/230	2300

TRANSFORMERS

Qu.	KVA	Make	Type	Ph.	Voltages
1	3000	Wagner	HPW-30	3	36400x2400
2	4200	G.E.-Fur.	FOWT	3	13800x200/87
3	2000	G.E.	RVDDJ	1	60000/13800

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltages
1	12500	Whse.	60/25	13200/13200
1	5000	G.E.	60/50/60	6600/11000/6600
1	4000	G.E.	60/25	2300/2300/4000
2	2500	G.E.	60/60.5	2300/2300
1	1000	G.E.	25/58.3	4400/2300
1	800	Al. Ch.	3560	11000/2300

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	4000	G.E.	Condensing 425 — 750 F.T.T. Surface Condenser 3/60/2300/4000 V Direct conn exciter.
1	1500	Whse.	Auto. extraction 190 lbs.—600° F.T.T. 90 lb. extraction 3/60/240 V. Dir. conn. Exc.
1	1000	Moore	Auto-Ext. Cond. 175/200 # I.S.P. 5/20# G. Ext. Surface Condenser—3/60/2300.
1	1000	G.E.	Non-condensing 175/200 lbs. I.S.P. 5/30 lbs. G.D.P., 480/3/60.
1	750	G.E.	Condensing 265# I.S.P. 440V. 3 ph. 60 cy.—New—1944.

BELYEA COMPANY, INC.

43 Howell St., Jersey City 6, N. J.

CHECK WITH WAGNER FIRST

"Certified Rebuilt" Motors and Generators

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
300	Allis Ch. b.b.	EW	250	1000
200	Allis Ch. b.b.	EW	250	850
150	Whse.	SK-201	230	300/900
150	Whse.	SK-184	230	850
150	Gen. Elec..	BC-16	230	1700
100	Whse.	SK-173	230	850
100	Reliance	661T	550	1000/1800
100	Reliance	661-T	230	575/1150
75	Whse.	SK-153	230	1150
75	Cr. Wh. TEFC	5HE	230	850
75	F. Morse b.b.	DH-140	115	1800
66	G.E. dynam. (4)	TLC25	250	1000/2500
50	Whse. (2)	SK-143	230	850
40	Whse. (2)	SK-133	230	850
35	Whse.	SK-103	230	300/900
30	Imperial b.b.	1000	230	600/1600
30	Star b.b. (2)	SB	230	1750
25	L. A. TEFC	RNA	230	850

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V
500	Whse.*	2300 AC	250 DC
300	Allis Ch.	2300/440 AC	125/250 DC
250	Allis Ch.	2300/440 AC	250 DC
200	Whse.*	220/440 AC	85 DC
200	Gen. Elec.*	220/440 AC	125 DC
200	Whse.*	220/440 AC	250 DC
150	Gen. Elec.	220/440 AC	125 DC
150	Whse.	2300/440 AC	275 DC
125	Gen. Elec.*	2300/4600 AC	250 DC
105	Century b.b.	220/440 AC	70 DC
100	G.E.*	2300/440 AC	125 DC
100	Whse.	220/440 AC	250 DC
75	F. Morse b.b.	220/440 AC	125/250 DC
75	Cont. b.b.	220/440 AC	125 DC
60	Gen. Elec.*	220/440 AC	60 DC
50	Gen. Elec.	220/440 AC	125 DC
50	Whse.	220/440 AC	250 DC
40	Whse. (2)	220/440 AC	250 DC
30	Gen. Elec.	220/440 AC	125 DC
30	Gen. Elec. (3)	220/440 AC	125 DC
30	F. Morse b.b.	220/440 AC	24 DC
25	Whse.	220/440 AC	125 DC

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
300	Al. Ch.	MECW	125/250	1200
250	Allis Ch. b.b.	EW	250	1200
175	Allis Ch. b.b.	EW	250	1200
150	Gen. Elec.	BC	250	1800
135	Whse.	SK-184	250	1150
105	Century b.b.	1500 amp.	70	1200
100	Whse.	SK-173	250	1150
100	Whse.	SK103	230	1500
100	Allis Ch.	E	125	1200
100	Reliance	661T	550	1200
75	Whse.	SK	250	1500
75	Cont. b.b.	D109X	125	1150
75	F.M. b.b.	DG	125	1800
75	Cr. Wh. bb (2)	CCD	250	1150
50	Whse. (2)	SK-143	250	1150
40	Whse.	SK-133	250	1150
35	Gen. Elec.	BC32	125	1500
35	Whse.	SK93	125	1750
25	C W b.b.	CCD	250	1200

A. C. MOTORS — 60 CYCLE

HP	Mfr.	Type	Volts	Speed
700	G.E.	Synch.	2300	514
700	Allis Ch.	Sq. Cage	440	900
600	G.E.	Slipring	2300/440	600
600	G.E.	Sq. Cage	4000	1800
500	G.E.	Slipring	2300/440	450
500	G.E.	Synch.	440	900
450	Allis Ch.	Synch.	440	400
400	Whse.	Sq. Cage	2300	514
400	G.E.	Synch.	440	450
350	Whse. (2)	Slipring	2300	450
350	Whse.	Sq. Cage	2300/440	1200
300	El. Machy	Synch.	2300/440	300
300	Al. Ch.	Sq. Cage	2300/440	720
300	Whse.	Synch.	2300/440	600
300	G.E.	Slipring	440	300
250	Gen. Elec.	Synch.	2300/440	450
250	G.E.	Synch.	2300/440	720
250	Whse. (2)	Sq. Cage	2300/440	1200
250	L.A. (2)	Sq. Cage	2300	1800
225	G.E.	Synch.	2300/440	300
200	G.E.	Slipring	2300/440	600
200	Gen. Elec.	Sq. Cage	2300/440	1200
200	Reliance b.b.	Sq. Cage	2300/440	1800
200	Allis Ch.	Slipring	440	450
200	Gen. Elec.	Sq. Cage	2300/440	720
200	Cr. Wh.	Sq. Cage	2300/440	3600
200	Whse.	Sq. Cage	2300/440	900
200	E. M.	Synch.	2300/440	1200
175	G.E. (2)	Synch.	2300/440	720
150	G.E.	Slipring	2300/440	900
150	El. Machy.	Synch.	2300/440	360
150	Whse.	Sq. Cage	2300/440	900
150	G.E.	Synch.	2300/440	450
150	Allis Ch.	Slipring	2300/440	720
150	G.E. (2)	Sq. Cage	2300/440	720
150	Rel. b.b.	Sq. Cage	2300/440	1800
150	Allis Ch.	Sq. Cage	440	450
150	G.E. vertical	Slipring	4000/2300	1200
125	G.E. TEFC	Sq. Cage	2300/440	3600
125	Whse.	Sq. Cage	2300/440	900
125	Rel. TEFC	Sq. Cage	2300/440	1800
125	G.E.	Slipring	2300/440	450
125	E. M.	Synch.	2300/440	1800
125	Allis Ch.	Slipring	2300/440	900
100	Ideal	Sq. Cage	2300/4000	1200
100	L.A. b.b.	Sq. Cage	2300/440	3600
100	G.E.	Slipring	2300/440	514
100	G.E.	Slipring	2300/440	900

A. C. GENERATORS — 60 CYCLE

KVA	Mfr.	Type	Volts	Speed
1000	Whse. syn cond		4000/2300	900
625	Gen. Elec.	ATB	2300	450
600	Gen. Elec.	ATB	440	900
485	Allis Ch.	4 brg.	440	450
313	Gen. Elec.	ATB	440	450
275	G. E. 25 cycle	ATI	480/480	750
225	El. Machy.		480	720
225	Gen. Elec.	ATI	240/480	900
150	Whse.		2300/480	600
125	Whse.		2300/480	900
75	El. Machy.		2300	900
54	G. E.	ATB	240/480	1200
37½	Whse.		240/480	1200

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TELEPHONE MONROE 6-7409

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4—1285 HP B & W Boilers rated 225 lbs. steam pressure. A.M.S.E. Code. Last used in 1953. Excellent Cond. Loc. Albany, N.Y. Price upon request.

PHILADELPHIA TRANSFORMER CO.
2829 CEDAR ST. PHILA. 34, PA.

30 & 40 HP High Pressure E. City Boilers
200 & 75/90 HP Reversing Marine Diesels
150 HP GE Slip Rg. Motor—600 RPM
5 Ton Shaw Traveling Crane—63'2" Span
2—50 HP Package Boilers—oil or gas
42"x88'x⅞" Welded Steel Smoke Stack
72x18' HRT Boiler—450 HP Oil Packaged
30 & 20 Ton YORK Ammonia Compressors w/mtrs

H. & P., 6719 Etzel, St. Louis 14, Mo.

POWER PLANT

875 KVA Diesel Generator Set, Chicago-Pneumatic 1000 HP, 8 cyl., 4 cy., 327 RPM, 16" x 20", air start, direct coupled to:

General Electric 875 KVA, 700 KW, Alternator, 3/60/6900 volts, with belted exciter.

Including: Switchboard, starting air compressor, air tank, oil pump, controls, valves, oil filters, oil clarifier, gauges, pumps, intake and exhaust silencers, tools and spare parts.

Unused Gov't Surplus Equipment, Ready to ship.

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WIRE WRITE OR PHONE CAnal 6-2900

SQUIRREL CAGE MOTORS

3 phase 60 cycle, 220 or 440 volts (*2300 volts or higher)

HP	MAKE	TYPE	SPEED
1250	*Al.-Ch.	ANW	3600
800	*Westg.	CS	3600
700	*Westg.	CS	1200
500	G.E.	KT-424	450
300	*G.E.	K-6346Y	1200
250	G.E.	KT5508	1800
250	*L-Allis	OGK-148	720
250	G.E.	IK-17A	900
250	West.	CH-14	514
200	*G.E.	FT-540Y	2600
200	*Cr. Wh.	SC	900
200	Al.-Ch.	ABWWT	600

MOTOR GENERATOR SETS

KW	MAKE	A.C.	D.C.
1500	G.E.	13200	250
1000	G.E.	13200	600
600	Westg.	4600	250
400	G.E.	2300	270
400	Al.-Ch.	2200	120/240
200	G.E.	2300	250/275
200	Westg.	4160/2280	275
200	Ridgeway	2300	250
175	G.E.	440	125
150	G.E.	2300	125/250
150	Al.-Ch.	2300	275
150	Westg.	2300	125/250
150	G.E.	440	275
100	G.E.	2300	250
100	Westg.	440	125
100	Elec. Mch.	440	125
100	G.E.	440	125
90	G.E.	440	60
75	G.E.	440	125
50	Reliance	440	250
50	Ideal	2300	250
50	Westg.	440	125
50	G.E.	440	125
35	Westg.	2300	150
25	Westg.	220	300
25	L-Allis	440	250

SYNCHRONOUS MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

HP	MAKE	TYPE	PF	SPD
1420	*West.		.7	900
750	*Westg.		1.0	900
710	*G.E.	ATI	1.0	720
600	*G.E.	TS-7640	1.0	600
550	*G.E.	TS-7657	1.0	514
400	*Westg.	H	.8	1800
400	West.	HG	1.0	900
300	G.E.	ATI	.8	720
300	*Ideal	SMM	.8	257
300	G.E.	ATI	.8	1200
250	G.E.	ATI	.8	900
250	G.E. (New)	TS-9747	.8**	720
225	G.E.	TS-6246	1.0	300
225	Elec. Mach.		1.0	360
200	F. Morse	TJC-285	.8	720
199	Elec. Mach.		1.0	720
150	F. Morse	TJC-285	.8	720
150	G.E.	ATI	.8	720
150	*Elec. Mach.		.8	1200
150	Westg.	HR	1.0	300
125	*G.E.	TS-7641	1.0	514
125	*G.E.	TS-6214	1.0	277
125	*Elec. Mach.		1.0	900
115	Elec. Mach.		1.0	240
110	G.E.	TS	.9	514
100	West.		1.0	900
100	Ideal	SNB	1.0	900

SLIP RING MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts or higher)

HP	MAKE	TYPE	SPEED
2000	*G.E.	MT	600
1500	*G.E.	MT-30	240
1000	*Westg.	CW	450
700	*Al.-Ch.	ANY	720
500	G.E.	I-17A	900
500	Westg.	CW	350
400	*G.E.	MT-412	450
300	*G.E.	IK-15A	1800
300	*G.E.	MT-568	720
250	*Westg.	HP-15M	600
250	*G.E.	I-17B	450
200	G.E.	IK-15B	900

D. C. MOTORS

*230 Volt

HP	MAKE	TYPE	SPD.
250	Westg.	SK-220	450/600
200	Westg.	SK-201	650
200	Cr. Wh.	CM	500
175	G.E.	ELC	750
100	G.E.	MPC	600/1000
100	G.E.	RC-19	575
100	G.E.	MCF	280/1000
75	G.E.	RCP-34	1750
75/35	Westg.	SK-151	600/1000

CHICAGO *Electric Co.* **1320 WEST CERMAK ROAD, CHICAGO 8, ILL.**

BOILER

One new unassembled Babcock & Wilcox Marine type "D". Two drum, 450 pound design, capacity 44500 lbs/hr., water walls, economizer, three burners. Complete with trim. Can be assembled and used as modern package type boiler. Will sacrifice.

FURNACE CONSTRUCTION CO., INC.

BOX 634 REDMOND, WASHINGTON

DIESEL GENERATOR SETS

3—1600 HP Fairbanks Morse Model OP 720 RPM, 1420 KVA FM 3/60/2400 volt generators. New 1949.

1—750 HP Superior 8 cylinder, 400 RPM, 500 KW Elec. Mchy. 3/60/2400 volt generator & auxiliaries.

3—600 HP Alco 6 cyl. 514 RPM, 400 KVA Elec. Mchy. 3/60/440 volts. New 1943.

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COMPLETE POWER PLANTS

STEAM — ELECTRIC — HYDRO — DIESEL

BOILERS *"Expert Orders Carefully Executed"* BOILERS

TRY US with your INQUIRIES for ALL POWER MACHINERY

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FOR SALE
18 NEW TURBINES

4 horizontal, 14 vertical, Westinghouse

Driving forced draft blowers—capacities ranging from 39000 to 56000 CFM and 16" to 24" pressure. Steam pressures 360 to 575#, back pressure 10#.

Will sell turbines separately if desired. *Price reasonable.*

Also—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volt. Used one year.

G. M. DeROSE

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DIESEL UNITS

1250 KVA (3) General Motors, 720 RPM
400 KVA. Elliott-Ingersol Rand, 600 RPM
250 KVA. GE-Chicago Pneu. 720 RPM
187 KVA Al. Chal.-Chicago Pneu. 720 RPM
62½ KVA (2) International Diesel Units; mounted on trailer

BOILERS

1000 HP. (2) B&W. 160#
600 HP. (2) B&W. 200#
250 HP. (2) B&W. 160#

TURBO GENERATORS

125 KVA. GE. 3/60/240/480 volts, noncond; 0 to 30# back pres.
250 KVA GE. 3/60/220/480 volts, 400# 30 to 110# bp.
250 KVA GE. 3/60/220/480 volts, 100/150#, 0 to 15# bp.

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6—100 KVA 60 cy. 1 ph. O.I.S.C. Transformers 2400-120/240.
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9—37½ KVA 60 cy. 1 ph. O.I.S.C. Transformers 2400-120/240.
19—15 KVA 60 cy. 1 ph. Dry Type 240/480-120/240
15—25 KVA 60 cy 1 ph. Dry Type 240/480—120/240
8—37½ KVA 60 cy. 1 ph. Dry Type 240/480—120/240.
3—50 KVA 60 cy. 1 ph. Dry Type 240/480—120/240.
3—10 KVA 60 cy 3 ph. Dry Type 480—208Y/120.
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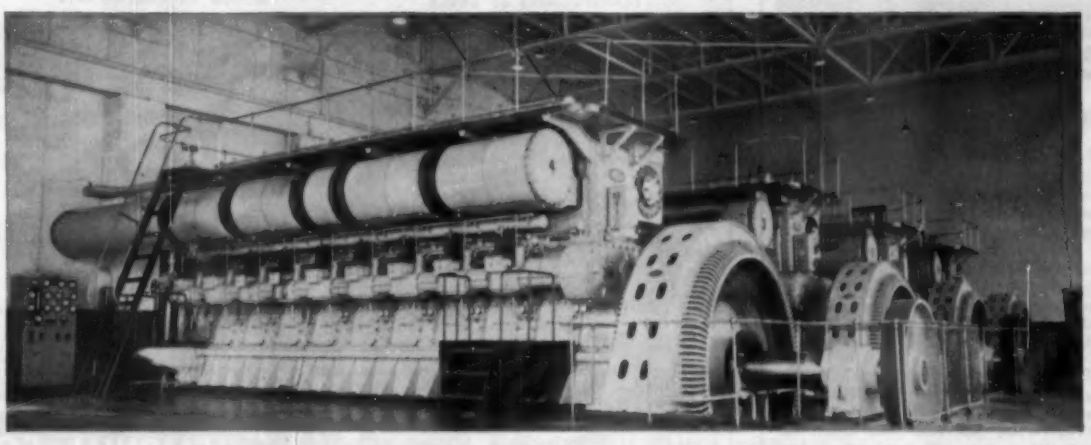
8100 KVA DIESEL POWER PLANT
FOR SALE – Complete or As INDIVIDUAL UNITS



THREE (3) BUSCH-SULZER (NORDBERG) DIESEL ENGINES, 3060 HP, 9 cylinder, 2 cycle, 240 RPM, Type 9 DHB-27, direct coupled to: THREE (3) 2700 KVA, E. M. C. ALTERNATORS, 3/60/2300/4160 V.

Each Unit Complete with all Auxiliaries. NEW 1943—Can be inspected operating.

CAN BE PURCHASED FOR CASH, OR TIME, OR ON LEASE.

HEAT & POWER CO., INC.

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3 G. M. 200 KW DIESEL GENERATOR SETS

Reconditioned by U.S. Navy

EQUAL TO NEW

Complete with motor driven starting air compressors, air tanks, dead front type generator switch panels and all other necessary accessories.

ENGINES

G.M. Model 8-268A—6½x7—1200 RPM—air starting—complete with engine operating panels, heat exchangers, cooling pumps, filters, strainers, governors, pyrometers, etc.

GENERATORS

Westinghouse 200 KW 250 KVA—440/3/60—1200 RPM—80% P.F.—continuous—drip-proof enclosure—direct connected exciter.

SIZE AND WEIGHT

Each unit, mounted on a pre-fab sub-base, is 12' 9 5/16" long, 3' 10½" wide, approx. 8' high. Weight of engine and generator only, 17,705 lbs. Each unit, with all accessories, about 27,000 lbs.

CONDITION

No expense has been spared to put these 3 units in "equal to new" condition. Don't miss this opportunity to buy! Inspection can be made at our warehouse, Curtis Bay, Baltimore,

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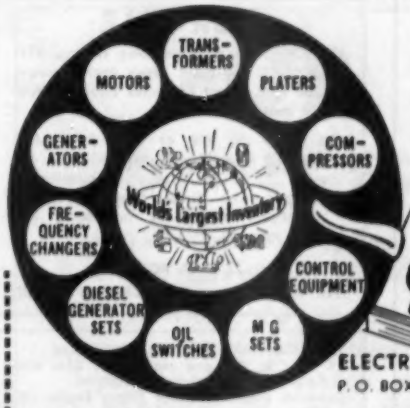
3—20" Centrifugal Pumps 15000 GPM (Worthington pumps) 35' T D H, driven by 200 HP Gen. Elect. Motors, 2300 volt 220-440 720 RPM.

PAUL OBERMAN
1910 Delmar, St. Louis, Mo.



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NEW AND GUARANTEED REBUILT • BOUGHT SOLD RENTED

JULY SPECIAL— F.O.B. Detroit • **4—1500 KW Motor Generator Sets**
2—Westinghouse • 2—Gen. Elec. • 250 V. D.C. 13,800-4160-2400V A.C., Syn.

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BOUGHT AND SOLD

We carry a large stock of rebuilt and guaranteed transformers, and invite your inquiries.

Custom-built transformers and coils manufactured to your specifications.

Expert Repair Service—all makes and sizes of transformers rewound, repaired and redesigned. Ask for our price schedule.

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40 Years' Dependable Service

There's more than 40% to 60% SAVINGS on

SCHOONMAKER DEPENDABLE
DIESEL POWER

because:

Each Schoonmaker-sold Diesel Engine Unit is fully REMANUFACTURED in our plants by highly skilled, factory-trained Diesel engineers. Only genuine factory-made and approved parts are used and all REMANUFACTURING is in strict accordance with manufacturer's recommended procedures. Prior to shipment every engine is subjected to a FULL LOAD operating test in accordance with DEMA standards.

The Schoonmaker Plants and Warehouses located in Eddystone, Penna. and Sausalito (San Francisco), California give NATIONWIDE SERVICE from Coast to Coast with modern, efficient and reliable facilities.

Our reputation and many years of experience and SPECIALIZATION in Diesel power equipment gives you value that money cannot buy elsewhere.

So—Buy SCHOONMAKER because you buy the FINEST in DEPENDABLE DIESEL POWER.

A PARTIAL LIST OF OUR INVENTORY

KW	MAKE	MODEL	HP	RPM
1180	Worthington	SEH-8	1685	360
1136	Fairbanks Morse	38D	1600	720
1100	General Motors	16-278A	1600	720
1000	General Motors	16-567B	1440	720
750	General Motors	12-567	1080	720
700	Worthington	EE-8	1000	327
675	Fairbanks Morse	38D	960	720
*500	Alco	6-12½x13T	750	600
500	General Motors	8-567	720	720
*350	Baldwin	VO-6	510	450
320	Superior	60-S-6	460	450
*320	Enterprise	DSG-6	460	450
300	Fairbanks Morse	32E14	450	300
300	General Motors	8-268A	450	1200
200	General Motors	8-268A	350	900
*160	Buckeye	80	240	600
148	Fairbanks Morse	32E14	225	300
100	General Motors	3-268A	150	1200
60	General Motors	6-71	90	1200

ALTERNATING & DIRECT CURRENT UNITS STANDARD AND SPECIAL VOLTAGES AS REQUIRED

*—Indicates NEW unit

ONE YEAR GUARANTEE!

A.G. *America's largest source of New and Remanufactured Diesel Power*

SCHOONMAKER CO., INC.

50 CHURCH ST., NEW YORK 7, N. Y.
PLANTS AND WAREHOUSES:
Eddystone, Penna. and Sausalito (S.F.), Calif.

Rebuilt HEMPHILL Guaranteed EQUIPMENT

TRANSFORMERS 60 CYCLE

Qu	KVA	Make	Type	PH.	Voltage
1	1000	Amer.	Pyranol	3	4150x480
1	750	G.E.	HT	3	4150x120/240
2	750	G.E.	H	1	4600x120/240
3	750	G.E.	Auto	3	4150x2400
1	500	Kuhl	OISC	1	4600x2300
9	400	Pitts.	OISC	1	4150x240/480
1	333	G.E.	H	1	12300x230/460
8	300	G.E.	H	1	12300x440
3	150	American	OISC	1	2400/4160-240/480
3	75	G.E.	Pyranol	1	2400/4160-240/480

SYNCHRONOUS MOTORS

QU	HP	Make	Speed	Type	Volts
1	1600	G.E.	514	ATI	4150
1	1600	Whse.	225	Mill	2300/4150
1	1000	G.E.	720	Mill	2300/4150
1	500	Whse.	450	MB	2300
1	500	EM	720	TEPC	2300
1	300	G.E.	600	ATI	600
1	200	Whse.	600	ATI	240
1	175	G.E.	720	ATI	2300
2	150	G.E.	1200	TS	4150
1	150	G.E.	1800	TS	220
1	150	Whse.	900	1810	220
2	150	Allis	360		2300
1	125	EM	900		4600
1	100	G.E.	900	TS	2300

SLIP RING MOTORS

QU	HP	Make	Speed	Type	Volts
1	500	G.E.	1200	M	2300/4150
1	400	Whse.	450	CW	550
1	250	Whse.	60	CW	440
2	100	Whse.	600	CW	440
1	200	G.E.	600	MT	440
1	150	A.C.	1800	AY RW	2300
1	100	G.E.	1800	IM	220
1	100	G.E.	600	IM	440
1	75	G.E.	900	IM	440
3	60	G.E.	1800	MT	220

MOTOR GENERATOR SETS

Qu	KW	Make	Speed	DC	AC
1	1000	G.E.	514	600	2300/4150 3ph
1	1000	Whse.	720	600	2300/4150 3ph
1	1000	Whse.	720	275	2300/4150 3ph
1	300	G.E.	1200	250	2300/4150 3ph
1	300	G.E.	1200	250	2300/4150 3ph
1	200	Whse.	900	250	2300/4150 3ph
1	150	C.W.	600	125	220/440 V
1	100	G.E.	900	250	2300 3ph
3	97	G.E.	1200	60	4150 3ph
1	75	G.E.	1800	250	220/440 SC
1	60	Whse.	1200	60	2300V
3	60	EM	1200	125	220
1	30	Whse.	900	250	480
2	30	G.E.	1750	240	220/440
1	25	G.E.	1800	230	220 V 3ph
1	20	EM	1800	125	220 V
1	7½	Allis	1800	125	220/440
2	5	G.E.	1800	125	220/440
3	1½	G.E.	2668	800 cy 1 ph	220/440
2	3	G.E.	1800	250	220/440

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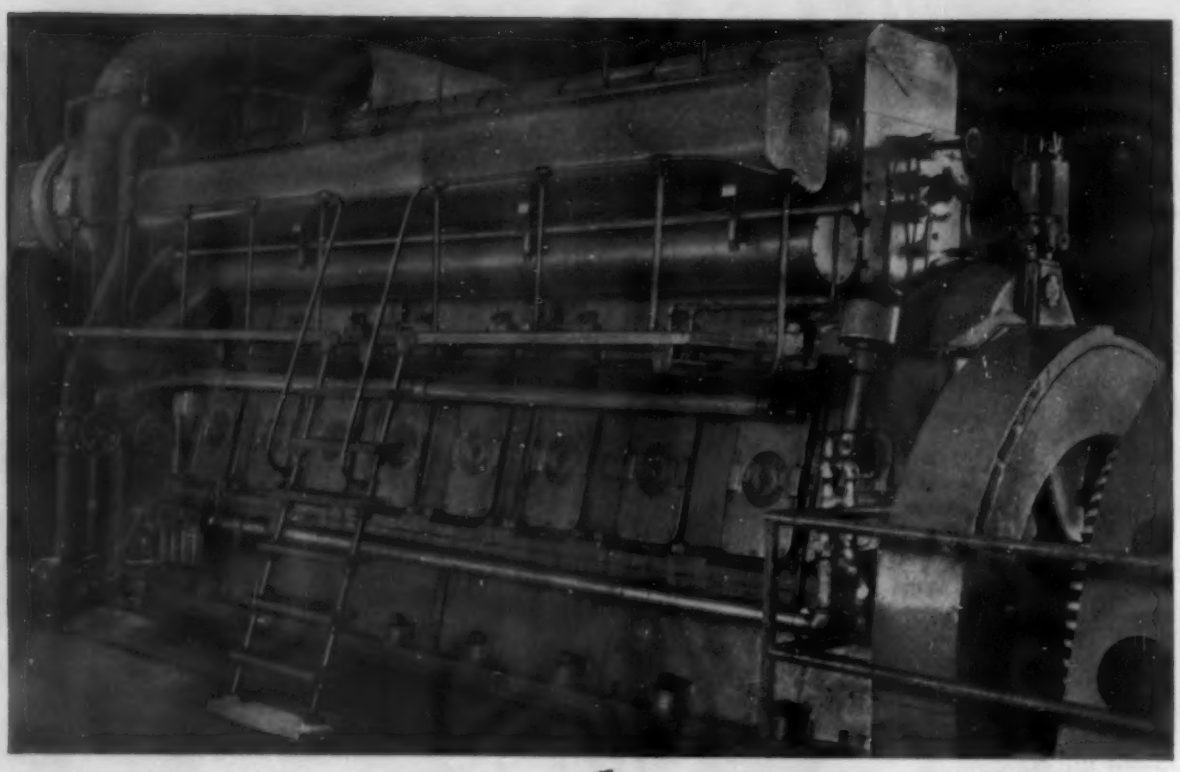

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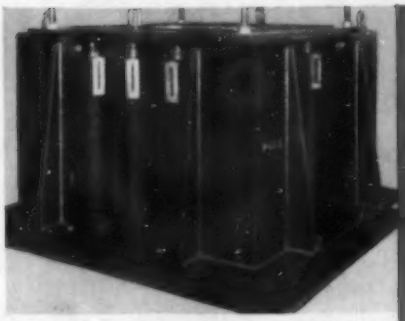
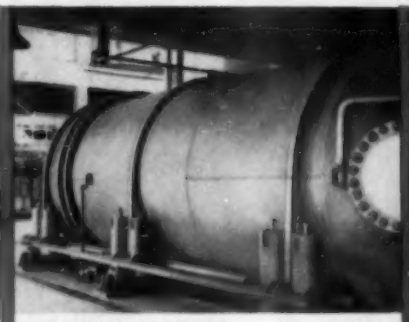
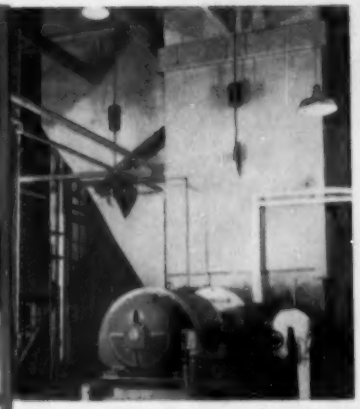


Base for supporting refinery tower, provided with Grinnell Spring Hangers for flexible support.



Grinnell Spring Hangers on large vessel of catalytic cracking unit in oil refinery.



Induced draft duct and blower in power station. Operates at about 500°F. Supported by Grinnell Spring Hangers.

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GRINNELL PRE-ENGINEERED SPRING HANGERS

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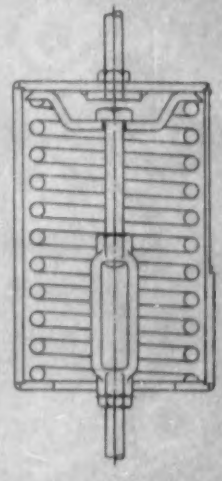
- 18 sizes available from stock — load ranges from 53 lbs. to 12,000 lbs.
- Easy selection of proper sizes from simple capacity table.
- Installation is simplified by integral load scale and travel indicators.

*Precompression is a patented feature.



VARIABLE SPRING HANGER FIG. B-268

Fig. B-268, Type A, is designed for attachment to its supporting member by screwing a rod into a bushing in the top cap of the hanger. Adjustment of the hanger load is accomplished by turning the turnbuckle on the lower hanger rod until the hanger picks up the load and the load indicator points to the desired position. Six other types of attachment are available.

Grinnell Variable Spring Hangers are also available in half sizes (Fig. B-82); and in double spring sizes (Fig. B-98).

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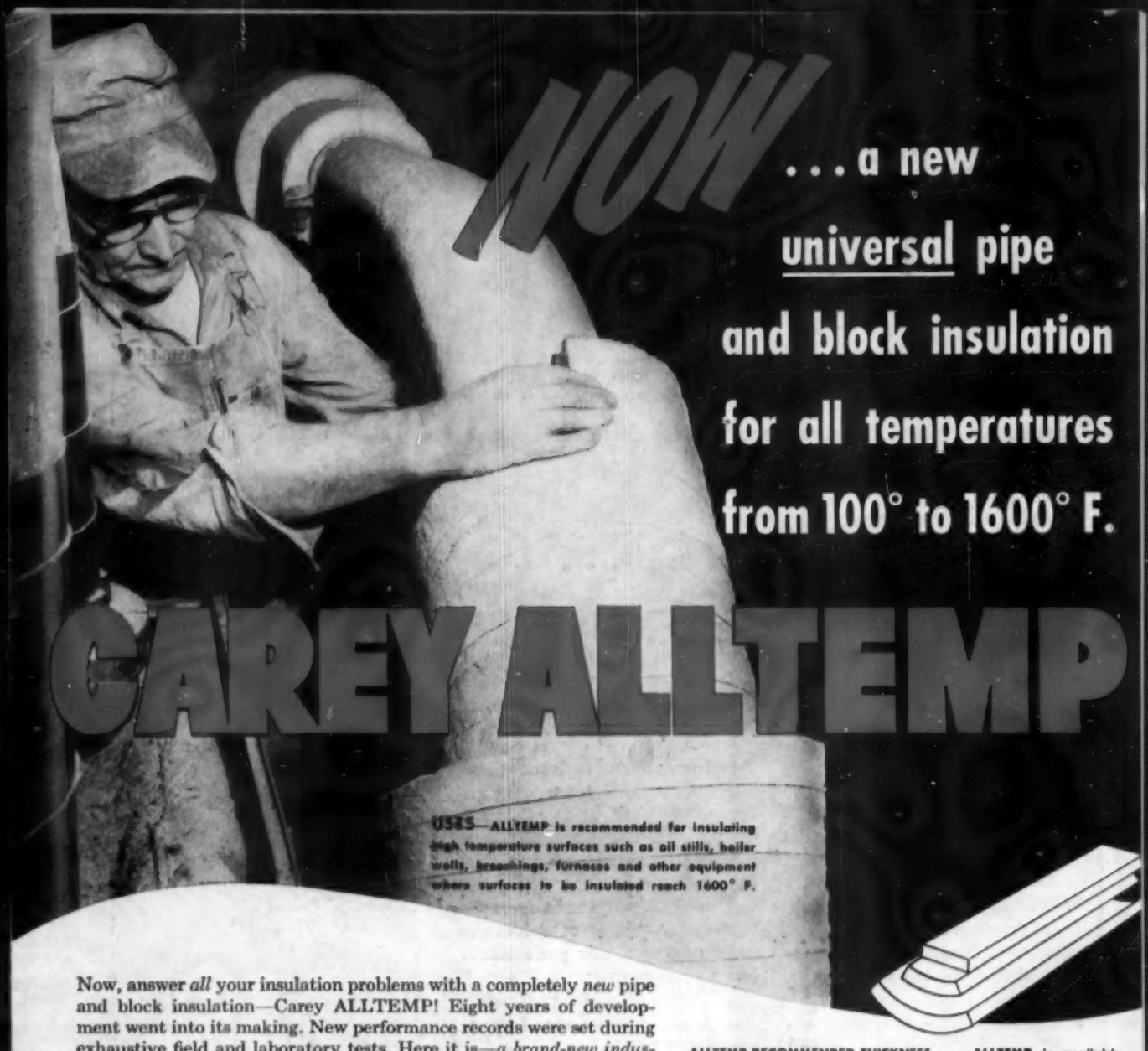

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ALLTEMP RECOMMENDED THICKNESS

Nominal Pipe Size Inches	Temperature Difference °F 80° Air					
	200	400	600	800	1000	1200
	Nominal Thickness, Inches					
1½ & Under	1	1	1½	2	2½	3
2	1	1½	2	2½	2½	3
2½	1	1½	2	2½	3	3½
3	1	1½	2	3	3	3½
3½	1	1½	2	3	3½	3½
4	1	1½	2½	3	3½	4
4½	1½	2	2½	3	3½	4
5	1½	2	2½	3	3½	4
6	1½	2	2½	3½	4	4½
7	1½	2	2½	3½	4	4½
8	1½	2	3	3½	4	4½
9	1½	2	3	3½	4½	5
10	1½	2½	3	4	4½	5
11	1½	2½	3	4	4½	5
12	1½	2½	3	4	4½	5
14 & Over	1½	2½	3½	4	4½	5½

ALLTEMP is available in clean, easy-to-handle flat and preformed blocks. "Nesting" O.D. pipe covering sizes provide accurate, tight fits for multiple layer construction. Only a limited number of "prime" units are necessary for unusual assemblies.

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